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Pliny's Historia naturalis

The most popular natural history ever published

Having had occasion to look carefully into the matter of early editions of PLINY's *Historia Naturalis*, I have been greatly impressed with the influence it has had on the students of natural things since the latter days of the Roman Empire, through the Dark and Middle Ages and the Renaissance, and almost until the dawn of the nineteenth century. In all this long space of years it seems to have been the most important work of its kind.

Thus for the fourteen hundred years betwixt PLINY's death and the appearance of his book in print, no other work contributed so much to keep natural history alive; and as we shall see later, for the three hundred years following the appearance of the first printed edition in 1469, it was still *the* great authority, read, studied, and quoted by all students of natural history. It was the foundation of all other natural history works of early times, such as the encyclopædias of BARTHOLOMAEUS ANGLICUS, KONRAD OF MEGENBERG, *et aliorum* — to say nothing of the works of ALDROVANDI and GESNER.

CAIUS PLINIUS SECUNDUS, born A. D. 29 and died at Pompei 79, was one of the most learned men of his times, one of the most industrious students (his nephew in a letter tells that « He deemed all time wasted that was not employed in study »), and one of the greatest readers of his or any other time. A most industrious compiler, he states in the preface to his *Historia* that therein are set forth some 20,000 facts, taken from some 200 books and from over 100 selected authors. (These amount actually to 473 : 146 Roman and 327 Greek authors). Thus, while his principal authority was certainly ARISTOTLE, he collected data wherever he found it, and but for his devoted labors, a vast deal of the material preserved in his *Historia* would have been lost to the world.

As to the esteem in which his book was held during Renaissance times, the data to be cited later concerning the number of editions issued in those days will amply testify. For the commendation given him and his work by scientific men of a later day, see BUFFON in his « Premier Discours sur l'Histoire Naturelle », and HUMBOLDT in « Cosmos ». While CUVIER in « Biographie Universelle », Vol. 35, article PLINE, among other things says : « The work of PLINY is one of the most precious monuments that has come down to us from ancient times and affords proof of an astonishing amount of erudition ... This work was the Encyclopedia of its age ... The immense treasury which he opens up to us ... renders his work one of the richest repositories of the Roman language ... Despite the faults which we are obliged to admit in him when viewed as a naturalist, we are bound to regard him as one of the most meritorious of the Roman writers. »

One of PLINY's great faults was that he was uncritical and hence included in his book a great deal of hearsay data, often of improbable character, the leaving out of which would have greatly improved his *Historia*. But a careful looking over of his tomes will also bring to one a realization that for a vast deal of natural history data common to us now and presumed to be the fruit of modern research, we must thank our old Roman writer. Then too, it is greatly to PLINY's honor that he quotes his authors by name, giving credit where credit is due. Where even ARISTOTLE says « it is said », « we read », « it is reported », PLINY specifically names his authority. There are « research » men to-day who might well follow the example of this credit-giving old Roman.

The first ten books of PLINY's great work were probably put in their present shape about 77 A. D. During the next two years, PLINY was engaged in revising the remainder of the *Historia*. Left unfinished or at any rate unedited at the time of his tragic death in the eruption of Vesuvius in 79 A. D., it is probable that but few additions were made by the author's nephew and literary executor, PLINY THE YOUNGER, before this great work was given to the world. PLINY's early and unfortunate death must surely account to some extent for the somewhat inchoate condition of the *Historia*.

From 79 A. D. until 1469, PLINY's work existed in manuscript. However, during the Dark and Middle Ages the *Historia* seems to have been *the* work on natural history, and copies were made in great numbers as is evidenced by the fact that some 200 manuscripts are

extant to-day. Naturally, however, the reader is more interested in the early printed editions of the *Historia*, the making which known is the purpose of this article, and to these we will now proceed.

In the course of extensive search into the old literature of fishes for the formation of the Pre-Linnæan Section of Dr. BASHFORD DEAN'S *Bibliography of Fishes*, so ably begun by my predecessor as editor of that work, the late Dr. CHARLES R. EASTMAN, I have had occasion to go pretty thoroughly into the matter of the early editions of PLINY'S *Historia Naturalis*, or *Historia Mundi* as it is sometimes entitled in keeping with its encyclopedic nature. These were found to be so numerous as apparently to justify the title of this article, and since so much data is at hand it has seemed worth while to bring this together into definite form and put it on record.

Much of this material, it is true, is found in categorical form in GEORGE RUDOLPH BOEHMER'S « Bibliotheca Scriptorum Historiæ Naturalis »(2 vols. of 2 pts. each)Lipsiæ. 1783-86, vol. I, part 1, pp. 186-211. However, this work is very old and very hard to find — the only copy in the United States known to me being in the Library of Congress — and the data are set so obscurely on its pages as to be very hard to get at. Now BOEHMER uniformly gives his authority for each edition, and his accuracy has been checked thoroughly and found satisfactory. Against him have been checked the extensive list of editions (81 editions *ante* 1800) in the British Museum, which constitutes the largest collection of the *Historia* known to me (catalogued in 1893); and the catalogues of the libraries of the American Museum, Columbia University, the New York Public Library, the Library of Congress, and the editions listed by GEORGE PARKER WINSHIP in his « Census of Fifteenth Century Books owned in America », and by J. F. BRUNET in the 1863 edition of his « Manuel du Libraire ». And it should be noted that all these lists were made from the books themselves. Further against this resulting combined list, I have checked the editions of the *Historia* found in the scores of booksellers' catalogues inspected in the past four years. In short there is every reason to believe that the data resulting from all this work is accurate. There is probably some duplication but it is believed that this is very small.

However, it must be clearly understood that this article is not primarily an essay in bibliography, a study of the editions of the natural history as editions, but is what its title indicates — an effort to show the great popularity and influence of PLINY'S work during

the 450 years following the invention of the printing press and its first issue therefrom.

The first printed book was issued from GUTENBERG's press somewhere between 1450 and 1455. If in the former year then but a scanty interval of nineteen years elapsed before JOANNES SPIRA at Venice brought forth the first edition of PLINY's *Historia* (1469), the first natural history book to be read from the printed page, the *editio princeps* of a work of which a flood of editions appeared at once.

In keeping with many other early incunabula, this 1469 edition lacks a distinct title, but has an inscription found on folio 1 recto, which abounds in abbreviations and curious letters which cannot be reproduced here without cutting certain types. For a facsimile of this first page see the catalog of the British Museum. The first part of this inscription is taken from the sketch of PLINY's life by SUETONIUS, the second comprises the opening lines of the preface to the *Historia*. In modern lettering this page reads in part : « *Plinius secundus novocomensis equestribus militiis industrie functus ... (line 12) Libros Naturalis Historiæ novitum camoenis quiritium tuorum opus natum apud me proxima futura* », etc. In brief it may be set thus : *Historia Naturalis*, Venice, J. SPIRA, 1469.

The five copies of this edition in the library of the British Museum are without pagination, catchwords, or signature marks. They consist each of 355 folio leaves, of which the nineteenth and the last are blank. There are 50 lines to a full page. The first page of one copy has an illuminated border, and at the head of each book is a finely illustrated initial. The paragraphs also have colored initials but these are less beautifully done. These initials being done by hand, no two copies are alike in this respect.

There are in this country two copies of this first edition; one is in the library of Princeton University, the other among the books belonging to Mr. C. W. CLARK, JR., of San Mateo, California.

There are, it is true, two earlier editions listed by BOEHMER and others, but noted as doubtful by the former. One is alleged to have been published at Venice by SPIRA in 1461. The other, listed on the authority of HALLER is said to have been printed at Verona in 1468, but no publisher is named. However, all the authorities agree that the 1469 edition is the first, so these reputed editions will be disregarded.

The second edition was printed by SWEYNHEYM and PANNARTZ at

Rome in 1470. It is also in folio. American copies are in the Annmary Brown Library, Providence, R. I., and in the collection of Mr. CLARK. Another folio edition of 1470 is said to have issued from the press of NICOLAS JENSON at Venice. This seems pretty authentic. Not so, however, is the folio of the same date from Parma, alleged to have been published by STEPH. CORALLUS. Also doubtful is an alleged edition of 1472 from Parma. BOEHMER lists both but marks them doubtful. They will be disregarded in the enumerations in this article.

An undisputed third edition is the very beautiful folio published at Venice in 1472 by JENSON. Five copies of this are in the British Museum, and ten copies are to be found in the United States as follows: Library of Congress, Newberry, John Crerar, Harvard, Yale, New York Public, and Princeton libraries; and in the collections of J. P. MORGAN in New York, HENRY WALTERS in Baltimore, and H. E. HUNTINGTON in San Gabriel, California.

From this time on (1472) a veritable flood of editions (almost entirely in folio) swept out upon the reading world, including a fourth Latin edition issued by SWEYNHEYM and PANNARTZ at Rome in 1473, and an Italian version by C. LANDINO printed at Venice in 1476 — the first edition ever issued in any language other than the Latin. In fact it seems as if nearly every town in northern Italy had set up a press especially to issue an edition of PLINY'S *Historia Naturalis*. From this one must judge that there was a great demand for this book, that it was widely read, that natural history enjoyed a great vogue, and that PLINY was the final authority.

Here is the data summarized for this wealth of editions. Omitting doubtful ones, it may be stated that before the news of COLUMBUS'S discovery of America reached the Old World twenty-three separate editions had seen the light of day, all in folio. And before the close of the year 1499 a total of thirty-nine separate editions had been issued from presses in the following towns: Brescia (6 editions), Milan (1), Parma (3), Rome (4), Treviso (3), Verona (1), Venice (21). Of these, thirty-eight were in folio, and one edition at Brescia was in quarto. All these editions were printed in northern Italy, one edition appearing simultaneously at Venice and Treviso.

During the next century (1500-1599) the flood of new editions of PLINY reached its height; no fewer than 89 have been recorded in the course of this study — an average of almost one per year. Of these, 27 were issued from Venice, which still retained its supremacy

as a publishing center. However, but one other Italian town was now represented—Verona with one edition. Paris issued 13 editions; Basle, 10; « Lugduni » — presumably the French town of that name, Lyons — 9; Frankfort — which town of the name is not clear — 6; Lyons, 5; Cologne and London, 3 each; Heidelberg and Selestad, 2 each; Argentoratum (Strasburg), Frankfurt-a-M., Geneva, Hagenoa (Hagenau), Hala Suecorum (Halle), Lugdunum Batavorum (Leyden), Vienna, and an unknown locality issued one each.

From the above analysis it is clear that the center of printing had shifted westward. Italy had lost her supremacy. France in this century issued 27 editions of PLINY, Switzerland fathered 11, and in nine or more German towns printing presses were active in issuing editions of PLINY. Marked also is the fact that the format of the editions showed changes. While folios still predominated (63 in number), there were 13 quartos, 5 octavos, and 3 duodecimos, together with various editions whose size of page could not be ascertained.

The seventeenth century witnessed a marked falling off in the number of editions of PLINY'S *Historia Naturalis* issued. I have been able to list but 43, just half the number for the time from 1500-1599. For this century Geneva and Paris lead with seven editions each, Amsterdam and Frankfort follow with five each, Cologne and Leyden are each credited with four, three were issued at Arnheim and Venice respectively, London and Mantua are credited with two each, and Madrid has one. Thus it is plain that while the number of editions issued decreased, the diversity of publication centers relatively increased. The format of these issues also showed considerable diversity. There were nineteen folios, seven octavos, eight quartos, and five duodecimos, the others not determined.

As compared with the seventeenth century, the number of editions of PLINY for the eighteenth century shows a diminution of more than fifty per cent — to 19. Seven appeared in Paris, three each in Amsterdam and Frankfort, one each in various scattered cities, and some could not be located as to place of publication. In format quartos and octavos prevail, with a few folios and some duodecimos.

Strange as it may seem I have been able to list more editions (32) for the eighteen-hundreds than for the preceding century. Their places of issue are chiefly in Germany, France, and England, in descending ratio, and their sizes mainly quartos and octavos, none are folios. Interesting to note is the fact that Latin editions still predominate, twenty of these editions being in that tongue. These

have not been seen, but are evidently critical editions, and are issued in 5 and 6 volume sets. Moreover, two sets run thus, 1892-1903, and 1895-1906, and these are the only volumes issued in the twentieth century so far as known.

There now remains to be had a brief consideration of the languages in which these editions appeared. First of all Latin predominates. Practically all the earliest editions were in this tongue, and Latin editions appeared until in the late eighteen-hundreds, as noted in the preceding paragraph.

In passing it may be well briefly to call attention to a few notable early editions in the Latin. Omitting the *editio princeps* and other very early editions which were devoid of distinct title pages, it is to be noted that the first of the British Museum editions having a real title page is that edited by JOANNES BRITANNICUS and issued at Brixia (Brescia) in 1496 under this title : C. PLYNIUS SECUNDUS *de Naturali Hystoria diligentissime castigatus.*

Attention may also be called especially to the folio edition issued at Paris in 1516, and to those printed by FROBENIUS at Basle in 1525 and 1530, with ERASMUS as one of the editors. Notable editions came from Paris in 1526 and 1543, and one from Basle in 1539, to each of which ERASMUS contributed a preface. Likewise the Lugduni 1548 edition issued by the brothers BERINGARUS had a dedication by ERASMUS. In 1635, the celebrated JAN DE LAET edited an edition in duodecimo (the third in this format), issued by ELZEVIR at Leyden. Another celebrated edition is that of 1668-69 (HACKIUS) at Amsterdam and Leyden, having as commentators, BARBARUS, PINTIANI, RHENANI, GALENUS, DALECHAMP, SCALIGER, SALMASIUS, VOSSIUS and others.

The first critically edited text seems to have been that in Latin in 5 volumes quarto, by the Jesuit HARDOUIN at Paris in 1685. This served as a textual basis for a large number of following editions. Possibly the most famous of the older editions in Latin is the octavo issued at Leipsic in 1778-91 under the general supervision of J. G. F. FRANZ, and for which there were utilized notes and comments by BARBARUS, DALECHAMP, GALENUS, GRONOW, HARDOUIN, PINTIANI, RHENANI, SCALIGER, VOSSIUS and others. Most notable perhaps of all Latin editions is that of 10 volumes in 13 issued at Paris in octavo in 1827-32, under the editorship of AJASSAN DE GRANDSAGNE, with notes on the animals by the illustrious CUVIER. These notes on the animals are, so far as I know, still the basis of our identification of PLINY's animals — certainly in the latest French and English versions.

Let us now take up a study of editions in languages other than Latin, understanding that so far as is known, all editions, not noted in other languages, appeared in Latin.

The first translation out of the Latin has been held to be one attributed to the Florentine LANDINO and reported issued in folio at Rome in 1473. This BOEHMER lists on the authority of HALLER, but BRUNET says of this version and edition that it is « *supposée* ». The authorities generally agree that the first authentic version is that by LANDINO in the « Fiorentina » (Florentine dialect) issued apparently simultaneously at Venice and Treviso by JENSON in 1476 in folio. A copy of this very fine edition in the British Museum has no distinct title page, but begins « *Historia naturale di* C. PLINIO SECONDO *tradocta de lingua Latina in Fiorentina per* C. LANDINO ».

From all available sources (mainly BOEHMER and the catalog of the British Museum) it has been ascertained that apparently all the Italian versions were printed at Venice : in folio in 1476, 1481, 1489, 1501, 1516, 1524, 1535, 1586, and 1589; and in quarto in 1534, 1543, 1548, 1561, 1562, 1564, 1573, 1580, and 1603. Of these 18 editions, the British Museum contains 9 : 3 folios and 6 quartos. Some of these later versions are by ANTONIO BRUCIOLI and others by L. DOMENICHI.

Although the first Latin edition of PLINY published in Paris is dated 1511, and although seven other Latin editions had appeared from that city prior to 1562, no full version in the French language had yet been printed. The nearest approach was a partial translation by DE CHANGY in quarto at Paris in 1542. This is probably the original of an octavo which was printed there by N. BRETON in 1559 under the title : « *Sommaire des Singularitez de* PLINE. *Extrait des siez premier Livres de son Histoire Naturelle,* par P. DE CHANGY. »

The first full French version (translated by DU PINET) was issued at Lyons in folio in 1562. A 2 volume folio version by the same author was also printed at Lyons in 1566, while other editions augmented by notes were issued there by different printers in 1581, 1584 (2 vols), 1587, all in folio. The first French edition published in Paris seems to have been the 2 volume folio of 1608; other folio editions in French from Paris are dated 1615 and 1622, while another French edition was issued at Geneva in 1625.

For modern critical versions in their mother tongue the French are certainly due much credit. The first is that in 12 volumes by POINSINET DU SIVREY issued by DESAINT at Paris in 1771-82. This has

Latin and French on opposite pages. The next is GUERCULT's 3 volume version, Paris, 1802. Best of all is PANCKOUCKE's edition, in 20 volumes, Paris, 1829-33. This was translated at least in part by AJASSON DE GRANDSAGNE with notes by CUVIER on the animals. There is an edition of 1840 by AJASSON, two by LITTRÉ of 1848-50 and 1851. All these are from Paris. There is also a French version of all PLINY's works (in 106 volumes) by AJASSON DE GRANDSAGNE at Paris (PANCKOUCKE) 1830-44. Presumably CUVIER's notes on the animals were used for all editions after that of 1829-33.

The *premier* German version seems to be the folio issued in 1511 at Frankfort by SCHMIDT and FEYERABENDT under the title « *Bücher und Schriften von Natur, Art, und Eigenschaft aller Creaturen* ». This was probably only an abridged version. Other folios were printed at Frankfort in 1565, 1571, 1584, 1600, 1618, and a poorly illustrated quarto edition in 1651, which embraces only books 7, 8, 9, and 10. Modern German versions are Rostock, 1764 (by DENSO); Frankfurt am Main, 12 volumes, 1781-88 (a translation by GRASSE entitled « *Cajus Plinius Naturgeschichte* »; Bremen 1850-53 and 1853-55; Leipzig, 1880-82 (6 volumes); all in octavo. The last is probably the best.

The first Dutch version, consisting of extracts from books 7-11, was entitled « PLINIUS *van Menschen, Beesten, Vogeln, und Visschen* », and was published at Arnheim by JANS JANZEN [OON] in quarto in 1610. Other editions are dated 1617 and [1620 ?] at Arnheim in quarto. At Amsterdam editions were issued in 1644, 1650 (12°), 1657, 1662, 1664, 1703, 1733, and all in 8° except as noted. These from 1657 on are the version of J. HENDRICKSZ. Copies of all these are to be found in the Library of the British Museum.

The first Spanish version (4°) was issued from Madrid in 1599. It, like other first editions in languages other than Latin, is a partial rendition entitled « *Traducion de los libros* [*VII & VIII*] *de Caio Plinio Segundo de la Historia Naturale de los animales* ». Another partial version appeared at Alcola in 4° dated 1602. Still another (a translation of book IX only) was issued in 4° at Madrid in 1603. Full versions in folio were issued from Mantua in Italy in 1624 and 1629, and another at Madrid 1624-29. All these versions were the work of G. DE HUERTA.

Of English versions of PLINY's *Historia Naturalis* there is a great paucity. The earliest Pliniana is a translation in octavo by one « I. A. » of P. DU CHANGY's partial French version of 1559, under the

title « *A Summarie of the Antiquities and wonders of the World, abstracted out of the sixtene first bookes of... Pliny* ». This was printed in black letter (presumably in 1565) for P. HACKET. In 1587 another edition of this was issued, but two years earlier HACKET brought out in 4° « *The Secretes and Wonders of the Worlde, a Book right rare and strange, containing many excellent properties given to Man, Beastes, Fowles, Fishes, Serpents, Trees, and Plants, translated out of Frenche* ». This, which is not in the library of the British Museum, but which is given here on the authority of LOWNDES' « Bibliographer's Manual of English Literature », is almost certainly an enlarged variant of the preceding version.

However, a real English version of the *Historia* appeared in Dr. PHILEMON HOLLAND'S « *Plinie's Natural Historie of the World* », 2 volumes, folio, London, 1601. In 1634, a second edition, also in folio, was issued in London. The next version appeared in 1847, when a translation in 3 volumes on the basis of HOLLAND was issued in 8° by the Wernerian Club. However, in 1828 an English version of the first and thirty-third books was privately printed by Dr. JOHN BOSTOCK as a specimen of a new prospective translation of PLINY. This full translation was delayed in publication, however, and did not appear (BOHN'S Classical Library) until 1855-57. It is entitled « *The Natural History of* PLINY *translated with copious notes and illustrations by* JOHN BOSTOCK, M. D., F. R. S., *and* H. T. RILEY, B. A. », and appeared at London in 6 volumes, 8°.

Thus two-thirds of a century have passed since our last translation of PLINY was issued. The authors of this version produced a good English translation, but neither was a trained zoologist. Dr. BOSTOCK was a fellow of the Royal Society and in his day an eminent student of Chemistry and Physiology. After the preliminary translation noted above, Dr. BOSTOCK had done books I and II and parts of others, when his life was cut short by an attack of cholera. RILEY, who seems to have been a classical scholar of standing, was then called in to finish the translation. The first two books at least are based on HARDOUIN'S text as found in the Paris edition of 1827-32. The zoological notes and identifications are CUVIER'S from the same edition. For a version in the light of present day knowledge there is certainly need and there ought to be a demand. In the matter of ARISTOTLE'S *Historia Animalium* we are far better off, since we possess in Prof. D'ARCY W. THOMPSON'S version (Oxford, 1910) the finest translation of ARISTOTLE in any language. And by the same token it is not

creditable to English scholarship that no translator of PLINY has arisen with a knowledge of Latin and zoology comparable to Prof. THOMPSON's for Greek and for the animal kingdom as shown in his version of ARISTOTLE.

And last of all there has come to hand the information that a Polish version in 10 volumes was published in 1845. Parts of the *Historia* had been issued in Latin at Cracow certainly as early as 1526, but so far as I know the above is the only Polish version. Further investigation would probably show that PLINY's *Natural History* has been translated into practically all the languages of Europe, and indeed it is on record that there is a version in Arabic.

Of illustrated editions there have been few. The first seems to have been that of Venice in 1513, issued by SESSA, with figures by ALEXANDER VE[RONENSE]. The second illustrated edition seems to have been that published at Venice in 1525 by SESSA and SERENA. The name of the illustrator has not been found, but probably the figures of the 1513 edition were used. This is also probably true of the illustrated Italian edition of Venice, 1535. The German version issued at Frankfort by HUMME in 1651 is also illustrated but the figures in the copy in Columbia University are poor. The British Museum copies of the Paris folios of 1723 and 1741 contain illustrations by J. HARDOUIN. Other early editions contain notes by HARDOUIN, but so far as I can find the above noted editions contain his only illustrations.

To recapitulate: there are listed in this paper 222 editions of PLINY's *Historia Naturalis*. Possibly some of these are duplicates despite the great care taken in this search. Of these 190 were published between 1469 and 1799, a space of 330 years. Probably a study of the complete records for the eighteenth and nineteenth centuries would show a larger number of editions than the 19 plus 32 listed. However, even if the list is not complete, this number is simply staggering.

Furthermore, there is now to be briefly considered a mass of miscellaneous data bearing on the question of the popularity of PLINY's *Historia Naturalis*. This concerns first the number of editions of single books or at most of parts only of the *Historia*; secondly, the number of books written about the *Historia* in the form of commentaries, laudations and criticisms, and corrections (the

« *castigationes* » of that day); and finally books dealing with the life and work of PLINY. There will be no analysis of these by either years, places of appearence, or languages. Suffice it to say they began to appear within ten years after the publishing of PLINY's printed book and have continued down almost to the present day. Various like data might have been collected from various sources, but the labor of checking these against BOEHMER and the catalogue of the British Museum (our two chief sources of reliable information) would have been so great and the final data of such small value that such checking has not been done. Hence our two great authorities will be the only ones quoted.

BOEHMER lists 42 works and editions of single books or at most parts only of the *Historia*. Of commentaries and « *castigationes* » he enumerates 62. Of biographical works relating to PLINY's life and natural history work about a dozen are listed. Thus, of Pliniana other than editions of the *Historia*, BOEHMER lists prior to 1785 no fewer than 116 works.

The catalogue of the British Museum lists 56 editions of separate books or parts of the Natural History. While under the headings « Annotations », « Commentaries », « Dissertations », « Memoirs », etc., it enumerates 109 works and editions (for some of these ran through half a dozen editions) referring to PLINY and his *Historia*. This gives us a total in the British Museum of 165 numbers of these miscellaneous publications. To these let us add BOEHMER's 116 and we get a grand total of 281 pieces of miscellaneous Pliniana (Natural History) from about 1485 to the present.

To make a final summation : to the 222 editions of the *Historia* accounted for in this paper let us add the 281 miscellanea noted in the preceding paragraph, and we get a grand total of 503 volumes of Pliniana (Natural History). Of the editions prior to 1800 let it be recalled that the Library of the British Museum alone possesses 81. Now the only other corresponding natural history book of the early days of printing was ARISTOTLE's *Historia Animalium*. Of this work, the Pre-Linnæan section of the Bibliography of Fishes lists only five editions, BOEHMER's list is likewise scanty, and the British Museum possesses only 12 editions in 6 languages The matter of counting editions of the *Historia Animalium* is, however, rendered difficult owing to the fact that there are more editions of ARISTOTLE's *Opera*

than of the *Historia* separately, but the number even of these is small compared to the number of editions of PLINY's work. Nor have I, in the course of my work as editor of the *Bibliography of Fishes*, found any natural history work comparable in great number of issues with PLINY.

After a presentation of the foregoing data it seems unnecessary to argue further that there has been established the truth of the thesis set forth in the title of this article — that PLINY's great work is by far the most popular natural history book ever issued from the press. And it is certain that in Renaissance times and even to the close of the seventeenth century, the most widely diffused, the most extensively read, and the most authoritative work on natural history was the book by CAIUS PLINIUS SECUNDUS entitled *Historia Naturalis*.

(*American Museum of Natural History*) E. W. GUDGER.
New York City.

Hunáyn Ibn Isháq [1]

Abú Zayd Hunáyn b.-Isháq al-Ibádi è una delle figure piu illustri del suo secolo, per vastità di cultura letteraria e scientifica, per operosità solerte di scrittore e specialmente di traduttore, per nobile integrità di carattere. Nato ad al-Hirah verso l'anno 194 H/809 Cr. da una famiglia cristiana (suo padre era farmacista), in una tribú quasi tutta convertita al Cristianesimo, li Ibaditi, venne, pare di buon' ora, a Baghdád, dove s'acconciò per studiare la Medicina con Yuhanna b. Masawayhi. Ma questi, un po' seccato dalle frequenti domande del curioso vivace alunno, un po' per invidioso timore che l'arte ippocratea, tanto stimata e tanto lucrativa a quei tempi, non restasse piú come particolar professione degli studiosi di Giundisabúr (specialmente delle due famiglie dei Bakhtishú e dei Masawayhi), lo respinse dalla sua scuola, aggiungendovi l'ironico consiglio di andare a fare il mercante o il rivendugliolo, com'era costume della gente di al-Hirah. Il giovane ibadita partí contrariato e piangente, e per due anni non si fece piú vedere a Baghdád, viaggiando per il paese dei Rum (i Bizantini): apprese il greco in Alessandria, lesse ed imparò Omero, e dopo una breve ricomparsa a Baghdád, pare si recasse ad al-Basrah per perfezionarsi nell' arabo in quella già celebre scuola grammaticale. Shihab al-din e Ibn Giulgiul (e Usaybi'ah sulla loro autorità) affermano che Hunayn studiasse colà in compagnia del celebre Sibawayhi (fra 177/793 e 180/796), alla scuola dell'illustre grammatico al-Khalíl b. Ahmad (175/791); ciò che dalla data stessa della morte di questi due filologi appare impossibile. La notizia va forse intesa nel senso ch'ei

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(1) *Isis* ouvre par cette étude une série de petites bio-bibliographies des anciens savants arabes ou arabisés (c'est-à-dire écrivant en langue arabe), tirées des sources originales imprimées ou manuscrites, et composées par M. le Bibliothécaire de l'Accademia Nazionale dei Lincei et de la Fondazione Caetani (fondation ayant pour but d'aider à la connaissance scientifique du monde musulman).

L'*Archivio di Storia della Scienza* a publié deux spécimens de ces biographies : Avicenna (IV, 258-270, 1923), Maimonide (V, 12-15, 1924).

vi studiasse le loro opere, che già facevan testo; come, tornando a Baghdád, vi portò il *Kitáb al-ayn*, il grande dizionario di KHALÍL (248 H. ? — cfr. GOLDZIHER *Abhandl.* I, 140).

Regnando AL-MAMÚ'N, HUNAYN in possesso ormai delle tre lingue, l'Arabo, il Persiano ed il Greco, oltre che del nativo Siriaco, si stabilì nella capitale degli Abbasidi, dove la sua perizia di traduttore gli aprì presto la casa dei piu illustri medici, quali GIBRAÍL figlio di BAKHTISHÚ, che prese ad onorarlo : ascoltava con diletto le sue traduzioni del Greco, lo chiamava maestro (*ya rabbán* HUNAYN) e predicevagli una fama maggiore di SIRGIS da Ra's al-ayn, il primo che avesse tradotto in Siriaco alcunché della scienza medica greca (al tempo di GIUSTINIANO ?). Lo stesso sprezzante YUHANNA B. MASAWAYHI s'affrettò, per mezzo del comune amico YUSUF B. IBRAHÍM, a riannodare i buoni rapporti col giovane ibadita; il quale attese con lui nuovamente allo studio e alla pratica della medicina, traducendo per YUHANNA, ora in siriaco e ora in arabo, parecchie opere di GALENO.

Avvenne che in quel tempo il Califfo, avendo veduto in sogno ARISTOTELE che disputava di filosofia e di scienza, s'appassionò sempre piú del sapere greco e diede ancor piú vivo impulso alla ricerca e traduzione delle opere greche, favorita già da i suoi predecessori AL-RASHÍD e da MANSÚR. Ottenutane licenza dall'imperatore bizantino, MA'MÚN incaricò alcuni dotti del suo seguito (AL-HAGGÁG B. MATAR, IBN BATRÍQ, SALMA *Sahib bayt al hikmah* o bibliotecario di corte; piú tardi anche HUNAYN) di recarsi nel paese dei Greci a farvi scelta e raccolta dei piú preziosi Mss. della scienza antica. HUNAYN fu quindi preposto al lavoro di traduzione, coll'incarico, oltre che di tradurre lui stesso, anche di rivedere e correggere le versioni anteriori. Si dice che MA'MÚN gli pagasse a peso d'oro le sue traduzioni in arabo. Nel contempo HUNAYN attendeva anche a lavorare per commissione di privati mecenati, che favorivano generosamente il rinascimento classico scientifico nell'Impero Musulmano : tali i tre figli di SHAKÍR, MUHAMMAD, AHMAD e HASAN, i quali spendevano *500 dinár* o monete d'oro al mese per stipendiare HUNAYN ed altri traduttori, HUBAYSH B. AL HASAN, THABIT B. QURRAH ecc.

Sotto i successori di MA'MÚN, HUNAYN fu ugualmente ben veduto ed onorato : WATHIQ specialmente faceva grande stima della sua dottrina di scienze mediche e naturali (vedi presso MA'SÚDI, *Murúg al dzahab*, VI, 180 e seg., le dotte conversazioni che questo, principe

soleva tenere a corte con i piú illustri naturalisti e filosofi). La consuetudine con i piú valenti medici della sua età, la sua naturale inclinazione, lo studio diligente ed indefesso, tutto il tesoro della scienza medica greca a cui egli poteva attingere liberamente, avevano fatto in breve di HUNAYN un medico perito ed egregio, specialmente in oculistica; sicchè egli attendeva anche all'esercizio della professione. La sua dottrina, la sua fortuna, ma specialmente l'abilità professionale in cui si era segnalato, gli suscitarono contro invidie ed inimicizie, sopratutto tra i suoi colleghi cristiani; i quali avevan rispettato HUNAYN traduttore, ma odiavano HUNAYN medico, e gli avvelenarono l'esistenza con intrighi e calunnie. Le peggiori disgrazie gli toccarano sotto il califfo AL-MUTAWAKKIL.

Il quale, incitato forse al sospetto dai suoi nemici, e dubitando che HUNAYN fosse per avventura subornato dall'Imperatore bizantino a suo danno, volle metterlo a prova. Fattolo venire alla sua presenza, una volta, e dopo avergli regalato una veste d'onore e un titolo di 50 mila dramme, gli richiese un farmaco col quale uccidere segretamente, e senza possibilità di essere scoperto, un suo nemico. Rispose HUNAYN che egli aveva appreso solo i rimedi utili all'umanità, nè pensava che il comandatore dei credenti potesse mai ricercarne di altri. Cacciato in prigione, vi rimase un anno, attendendo serenamente a scrivere e a tradurre di scienza; e, quando in capo all'anno fu richiamato dal Califfo e invitato a sciegliere tra grandi ricchezze deposte da una parte, e a lúi destinate se obbedisse alla rinnovata richiesta del veleno, o strumenti di supplizio preparati dall'altro canto; impavido, HUNAYN rinnovò la sua risposta, di non praticare nè conoscere altri farmachi, se non quelli benefici; e si disse pronto a morire. MUTAWAKKIL allora sorridendo lo assicurò di averlo voluto solamente mettere alla prova, e gli domandò che cosa veramente lo aveva impedito di soddisfare alle sue richieste, pur sotto la minaccia di una morte tormentosa. Due cose, soggiunse HUNAYN : la religione e l'arte; la religione ci comanda di fare il bene ai nemici come agli amici; e l'arte o professione medica, istituita a vantaggio dell'umanità, ci proibisce di far del male a chi che sia. Pienamente soddisfatto, MUTAWWAKIL colmò di doni l'integro ibadita, e lo tenne qual suo medico di fiducia, mandandolo a chiamare d'urgenza anche la notte.

Ma i suoi nemici non si arresero e prepararono al nobile HUNAYN nuovi agguati e calunnie. Secondo IBN AL-GIULGIUL, fu il TAYFUR (ISRAÍL B. ZAKARIYYAH) che, invidioso del favore e della superiorità intelletuale del suo correligonario, lo accusó al Giathalíq (Catholicos,

il primate o patriarca) ed ai vescovi di non aver voluto sputare sopra un libro contenente l'immagine dei Giudei che avevan crocifisso il Cristo. Hunayn fu scomunicato, e il diffidente Califfo diede ordine che non gli si somministrasse medicinale veruno preparato da Hunayn, se prima non l'avesse esaminato il Tayfúri. Hunayn allora ne sarebbe morto di crepacuore. Ma il fatto vien narrato assai diversamene in un ragguaglio autobiografico o *Risálah* dello stesso Hunayn intorno alle sue disgrazie. In questo scritto, improntato a profonda tristezza pur temperata da sensi di cristiano stoicismo, Hunayn si duole che gli abbian reso male per bene quelli stessi suoi colleghi e correligionari, a cui egli aveva comunicato il sapere degli Antichi; e narra come Bakhtishú b. Gibraíl, avendo fatto eseguire una *qúnah* (icóna : immagine; medaglia?) della Vergine (al-Sayyidah M'árt Maryam) con in grembo Gesú e gli angeli d'attorno — opera di grande bellezza artistica e di gran prezzo — la mostrasse a Muttawwakkil, che molto l'ammirò. Quindi, meravigliato della venerazione con cui Bakhtishú baciava alla sue presenza la sacra immagine, il Califfo gli domandò se tutti i Cristiani facessero altrettanto. Anche di piú, rispose l'astuto, tranne un solo uomo, ch'è al tuo servizio, e che camuffandosi da Cristiano, è un pessimo eretico (*zandíq mulhid*), non crede nè all'unità di Dio, nè alla vita futura; è ateo e spregiatore degli Apostoli. Costui, nonchè venerare la Vergine, ci sputerebbe sopra.— Chi è costui? riprese adirato Mutawakkil.— Hunayn.— Sia fatto venir qui.— Venne allora Hunayn, il quale tratto in inganno da un discorso che gli aveva fatto avanti il menzognero Bakhtishú, sia che pensasse di evitare noie ai Cristiani da parte del Califfo, sia che fosse per sè divenuto, dopo la lunga dimora nei paesi greci, avverso al culto delle immagini; spúto sulla *qúnah* della Vergine alla presenza di Mutawakkil. Allora il Calffo, per suggerimento del Giathalíq Thawdzusyus (Teodosio), chiamato a consulto, lo fece battere a nudo con cento nerbate, gli confiscó tutti gli averi, e lo tenne per 6 mesi in prigione nella Regia, rinnovandogli di tanto in tanto il supplizio del *Sawt* (lo scudíscio). Già da quattro mesi l'infelice penava nel carcere, quando l'Emiro infermò gravemente, nè si riusciva a curarne il morbo, tanto che egli prese a disperar della sua vita, e disperavano tutti i suoi medici. Questi allora con a capo il maligno Bakhtishú, tanto insisterono presso di lui che si liberasse dal maleficio dell'empio *zandíq* Hunayn, che il Califfo decise di dar l'ordine della sua morte. Ma la notte precedente all'esecuzione del ferale divisamento, narrasi che apparisse in sogno all'Emiro il Cristo risplendente

di luce e seguito da HUNAYN, e che gli dicesse di perdonare il suo fallo all'ibadita, il quale lo avrebbe in compenso guarito dalla sua infermità. Nella stessa notte HUNAYN udiva in sogno una voce che predicevagli la sua liberazione; « Sorgi e loda Iddio e magnificalo, chè ti liberò dalle mani dei tuoi nemici, e nelle tue mani ha posto la salute del Capo dei credenti ». La dimane infatti il Califfo fece venire alla sua presenza HUNAYN, si lasciò curare da lui con piena fiducia, e gli restituì tutto il suo favore, ordinando che ai suoi ricchissimi doni i medici che ne avevan consigliato la morte, aggiungessero, in ammenda, 10 mila dramme ciascuno. Così HUNAYN, dopo aver subito traversie e pericoli piú gravi di quelli toccati allo stésso GALENO, salì a grande potenza e splendore; ma non se ne valse per vendicarsi dei suoi nemici, cui generosamente perdonò.

HUNAYN ebbe due figli, DA'WÚD e ISHAQ, ai quali insegnò il proprio sapere e di medico e di traduttore. Chiuse a 70 anni la sua vita avventurosa ed operosa, nel primo martedì del decembre 1188 dell'Era d'Alessandria, l'ultimo giorno del safar 264 A. H./867 Cr., sotto il Califfato di AL-MU'TAMID.

Semplice, temperante, sistematico in tutte le sue abitudini, lavoratore indefesso, soleva dire che « la notte è il giorno dell'uomo di lettere » : il suo nome è legato a quasi tutta l'opera di versione ed elaborazione di cui fuoggetto presso gli Arabi la medicina antica. Oltre al suo lavoro personale di traduzione e di revisione, diresse ed allargò l'impulso di quell'umanesimo scientifico che caratterizza nello ambiente musulmano intelletuale il 3° secolo dell'H (9° di Cr.). Dotato anche di singolari attitudini didattiche, ebbe il merito di formarsi discepoli e collaboratori egregi, quali il figlio ISHÁQ e il nipote HUBAYSH. I manoscritti delle sue traduzioni, specialmente da GALENO, si spargevano per il mondo musulmano in grandissimo numero; e,quattro secoli dopo, USAYBI'AH ne vedeva ancora alcuni, appartenuti a MA'MÚN, vergati di mano dello scriba di HUNAYN, al Azraq, con correzioni e appunti critici scritti in greco dallo stesso HUNAYN. Questi codici crano scritti con un grosso carattere a grandi lettere, con righe largamente spazieggiate, sopra pergamena molto doppia e greve : il che, se ebbe per effetto di renderli piú duraturi, aveva forse avuto per iscopo immediato di farli fruttar di piú nella valutazione a peso d'oro, con cui è fama che il Califfo soleva retribuire l'opera di HUNAYN.

* * *

HUNAYN traduceva ora in siriaco ed ora in arabo, probabilmente a seconda della persona che gli commetteva il lavoro, od a cui pensasse

di dedicarlo. Le sue traduzioni, fra quelle che sono proprio opera sua e le altre molteplici che egli rivide e corresse, sono numerossissime e portano tutte l'impronta del suo inegno : fedeltà al testo, di cui spesso curava antecedentemente la lezione con senso critico, ed eleganza di dettato. AL-NADÍM, AL-QIFTI ed USAYBIAH le enumerano qua e là nelle biografie dei vari autori tradotti (cfr. WENRICH, LECLERC, e, per i medici, gli studi dello STEINSCHNEIDER, spec. *Die griechischen Aertze in arabischen Uebersetzungen* nel VIRCHOW's *Archiv*, 1891); noi ci limiteremo qui a rammentare che l'attività di HUNAYN quale traduttore dal greco si volse, con lavoro quasi enciclopedico, ai seguenti scrittori : 1° Medici (IPPOCRATE, GALENO, ORIBASIO, PAOLO D'EGINA, RUFO D'EFESO, DIOSCORIDE, TEOMNESTO ?); 2° Filosofi, Matematici e Scienziati diversi (PLATONE, ARISTOTILE, AUTOLICO, EUCLIDE, TOLOMEO, NICOLA DAMASCENO, ARCHIMEDE, MENELAO, APOLLONIO DI TIANA, ARTEMIDORO, ALESSANDRO D'AFRODISIA, PORFIRIO, TEMISTIO).

Passando ad enumerare gli scritti propri di HUNAYN, quali li elenca piú completamente ma anche piu confusamente USABIAH, li divideremo in due sezioni: 1° Rielaborazioni od illustrazioni delle opere greche da lui direttamente o indirettamente tradotte; — 2° Opere originali.

I. 1° Dalle traduzioni proprie ed altrui, HUNAYN recavò molteplici scritti minori, riassunti o compendi (*ikhtisár, giawámi)*, spigolature od excerpta (*thimar* = « karpós », *istikráǵ*), parafrasi e commentarii (*sharh, tafsir*): scritti piú spesso compilati a domande e risposte con intento didattico, come testi di insegnamento indirizzato specialmente ai suoi due figli.

Sono : 1° Sommario dei XVI libri di GALENO (cioè raccolta delle 16 opere scelte di G., che formarono nella scuola alessandrina il testo fondamentale dell'insegnamento medico), a domanda e risposta;

2° Compendio del libro di GALENO « Sul marasma », a domanda e risposta;

3° Compendio del libro di GALENO « Che il medico distinto debba esser filosofo », a domanda e risposta;

4° Compendio dell'opera di GALENO « Sui libri autentici d'IPPOCRATE e sugli spuri »;

5° Compendio del libro di GALENO « Incitamento allo studio della medicina » (traduttore HUBAYS), a domanda e risposta;

6° Compendio del libro di GALENO « Sullo sperma » (HUBAYS o HUNAYN ?), a domanda e risposta;

7° Spigolature del Commento di GALENO agli *Aforismi* d'IPPOCRATE,

a domanda e risposta; in siriaco, in 7 trattati, tradotti poi in Arabo : i primi 4 da Hunayn medesimo (?), gli altri da Isa b. Sahr Bakht;

8° Spigolature dal Commento di Galeno ai *Prognostici* di Ippocrate (Isa b. Yahya), a domanda e risposta;

9° Spigolature dal Commento di Galeno al libro d'Ippocrate « *Sul regime delle malattie acute* » (Isa b. Yahya), a domanda e risposta;

10° Spigolature dal Commento di Galeno al libro d'Ippocrate « *Sulle ferite della testa* » (Isa b. Yahya), a domanda e risposta;

11° Spigolature dai 17 trattati potuti ritrovare del Commento di Galeno all'opera d'Ippocrate « *Sui morbi epidemici* » (tradotto in parte da Isa b. Yahya, in parte da Hunayn stesso, prima in siriaco, poi in arabo, per Abú Giafar Muh. b. Musa), a domanda e risposta;

12° Spigolature dal Commento di Galeno « alla Farmacia » d'Ippocrate (tradotta anche da Isa b. Yahya), a domanda e risposta;

13° Spigolature dal Commento di Galeno Qatitriyyún κατ'ἰητρεῖον al libro d'Ippocrate « delle arie, dei tempi e dei paesi », a domanda e riposta;

14° Parafrasi al libro l'Ippocrate « dell'aria, dell'acqua, e degli abitanti », non compiuta [Trattasi qui, come suppone lo Steinsch., d'una medesima opera ippocratea, quantunque i titoli siano alquanto diversi ? Sembra che Hunayn ne traducesse in arabo il testo, e Hubays il Comm. di Galeno];

15° Parafrasi al libro d'Ippocrate « Sulla alimentazione (tradotto da Hunayn ?);

16° Spigolature dal terzo trattato del Comm. di Galeno al libro d'Ippocrate « Sulla natura dell'uomo » (una parte del testo fu tradotta da Hunayn; il Comm. da Isa b. Yahya);

17° Spigolature dal libro d'Ippocrate « Sui nati a otto mesi »;

18° Aforismi tratti dall' « Epidemia » d'Ippocrate;

19° Aforismi tratti dall'opera di Ippocrate « «Sulle arie e i paesi » e da quanto su questo argomento è detto negli « Aforismi » secondo il Comm. di Galeno;

20° Questioni sull'orina, estratte dall' « Epidemia » d'Ippocrate;

21° Questioni tratte dai quattro libri della Logica (?);

22° Libro sull'orina, tratto dalle opere di Ippocrate e di Galeno;

23° Compendio del libro d'Aristotile « del cielo e del mondo »;

24° Compendio al libro d'Ippocrate « sull'ernia testicolare » (? *al-nafakh*; — o *al-nafkh* : « de flatibus » ?);

25° Comm. all' « Igiene » di Rufo;

26° Comm. al libro di GALENO « sui medicamenti secreti », dove si spiega ciò che GALENO menziona a proposito di ciascun farmaco;

27° Lettera a SALMAWAYH B. BUNÁN sulla traduzione ch'ei gli aveva richiesta del trattato di GALENO « sulle abitudini » (tradutt. HUBAYS);

28° Pandette, compendiate da quelle di PAOLO DA EGINA (tradutt. HUNAYN);

29° Complesso delle opinioni concordi dei « due Insigni », IPPOCRATE e GALENO;

30° Compendio dei tre primi trattati dell'opera ippocratea « sull' Epidemia », a domanda e risposta;

31° Trattato sull'originarsi del feto (*Kawn al Gianin*), compilato da quanto ne dicono IPPOCRATE e GALENO;

32° Compendio del Comm. degli antichi Greci al libro d'ARISTOTILE « de caelo et mundo »;

33° Questioni preliminari, da servir di prefazione all'*Isagoge* di PORFIRIO;

34° Parafrasi dell'opera aristotelica *Fararah* (dell'equitazione o « ippica » ? — ovv. *Firásah*, della fisiognomica ?).

II. Scritti propri od originali. *a*) *Opere mediche :*

1° *K. al masail*, « Le questioni » o introduzione all'arte medica, dove son raccolti i princípi fondamentali di questa scienza. HUNAYN vi mise mano sotto AL-MUTAWAKKIL, il quale lo aveva nominato medico primario o *rais al-atibbá* in Baghdád; ma non la compì. Egli lasciò in abbozzo, su fogli sparsi, una parte dell'opera, che poi fu messa insieme e pubblicata dal discepolo e nipote HUBAYSH AL A'SAM con l'ampliamento e le aggiunte che questi vi mise di suo, come ci attesta uno dei commentatori dell'opera, IBN ABI SADIQ;

2° *K al 'ashar maqálát fil-'ayn*, « I dieci trattati intorno all'occhio », che furono composti separatamente l'uno dall'altro, ed ebbero parecchie redazioni in forma ora compendiosa ora diffusa. Ecco come l'argomento era diviso :

a) Natura e costituzione dell'occhio;

b) Nature ed utilità del cervello;

c) Del nervo visivo e dello spirito visivo, e come avvenga la funzione della vista;

d) Di tutte le varie norme che sono indispensabili per conservar la salute;

e) Le cause delle malattie che colpiscono l'occhio;

f) Dei sintomi delle malattie oculari; 7° della virtú di tutti i farmachi in generale;

g) Dei vari generi di medicinali propri dell'occhio;

h) Cura delle malattie oculari;

i) Medicamenti composti adatti alle malattie oculari. — I dieci trattati furono poi riuniti in un'opera sola dallo stesso HUNAYN su richiesta di HUBAYSH; e pare che piú tardi vi si aggiungesse un undicesimo ed ultimo trattato o capitolo, sulla cura chirurgica delle malattie dell'occhio.

3° *K. fi-l-ayn*, « Dell'occhio », in tre trattati, redatto a dom. e risp., per i due figliuoli DAWÚD e ISHÁQ : comprende 290 questioni;

4° *Maqálah fi tadbir al-náqihin*, « Il regime dei convalescenti », composto per ABÚ GIAFAR MUH. B. MUSA;

5° *Risálah fi qurs al'úd*, « Le pastiglie di aloè »;

6° *Risálah ila-l-Tayfúri fi qurs'l -ward*, « Lettera al Tayfuri sulle pastiglie di rosa »;

7° *K. ila al-Mu'tamid fima saalahu min al-farqi bayna l'-ghadzá wal dawá al mushil*, « Libro al Califfo Mutamid intorno alla distinzione da lui richiestagli fra alimento e medicamento purgativo », in tre trattati;

8° *K. Kuwa al aghdziyah*, « Le energie o proprietà degli alimenti »;

9° *Maqálah fil-daláil*, « Dei segni o sintomi », dove si descrivono le varie categorie di sintomi che conducono al riconoscimento d'ogni malattia;

10° *K. fil-nabd*, « Del polso »;

11° *K. fil-humayyát*, « Delle febbri »;

12° *K. fi ma'rifah awhá al-maidah wa-ilágiha*, « Della conoscenza dei dolori di stomaco, e loro cura »; in due trattati;

13° « Sullo stato delle membra » (?);

14° « Sul liquido dell'orina »;

15° « Della secchezza » = (irrigidimento) (*fi-l-yabs*);

16° « Sulla conservazione dei denti e delle gengive »;

17° « Su chi nasce a otto mesi » : libro a dom. e risp., composto per UMM WALÍD AL-MUTAWAKKIL (?);

18° « L'esame dei medici »;

19° « I princípi naturali degli alimenti, e il regime dei corpi »;

20° « Sui nomi dei medicamenti semplici » disposti in ordine alfabetico;

21° « Sulla denominazione delle membra, secondo l'ordine di GALENO;

22° « La costituzione o composizione dell'occhio »;
23° « Igiene dei sani nel vitto e nella bevanda »;
24° « Del latte (da GALENO?);
25° « Regime degli idropici »;
26° « I segreti dei medicamenti composti »;
27° « I segreti dei filosofi intorno al coito »;
28° « La costituzione *(Khalq)* dell'uomo »;
29° « Del bagno »;
30° « Del solletico (*dághdaghah*) »;
31° « Dell'angoscia della respirazione (dispnea) ;
32° « Della diversità dei gusti »;
33° « L'anatomia degli organi di nutrizione », in tre trattati;
34° « Come si origina il calcolo »;
35° « Sulla scelta dei medicamenti caustici »;
36° « Delle asque termali », a dom. e. risp.;
37° « Curiosità e sentenze (*nawádir*) dei filosofi e dei dottori; cultura dei dotti antichi »;
38° « Delle divisioni o classificazioni delle malattie oculari »;
39° « Della scelta dei medicamenti per le malattie oculari »;
40° « Dell'epilessia »;
41° « Appendice all'Igiene » (?);
42° « Risoluzione di alcuni dubbi di GIASYÚS d'Alessandria intorno al libro di GALENO, « Sulle membra affette d'infermità » (tradutt. HUNAYN o HUBAYS ?);
43° « Come eliminare le proprietà nocive degli alimenti »;
44° « Dell'abbigliamento » (? *K. al-zínah;* o invece *al-zánah*, dell' indigestione? In tal caso sarebbe una cosa medesima col num. 43 ?);
45° « Sulle proprietà delle pietre »;
46° « Libro d'ippiatrica »;
47° « Igiene dei denti ».

Tra le varie opere mediche di HUNAYN tradotte in latino e poi stampate, menzioniamo :

Isagoge JOHANNITII *ad Tegni* GALENI, o JOHANNITII *isagoge in artem parvam* GALENI (Venetiis 1487 ec.).

b) Lavori di scienza naturale :

1° *Maqálah fi tawallud al furrúg,* « Sulla nascita del pulcino » : vi si dimostra ch'esso nasce dalla chiara dell'uovo e si nutrisce del torlo;
2° « Del flusso e riflusso »;

3° « L'azione del sole e della luna » (da GALENO ?);
4° « Del fuoco che nasce tra due pietre »;
5° « Sulla causa per cui le acque del mare sono salse »;
6° « Sui colori » (da GALENO?);
7° « Dell'agricoltura »;
8° « Dell'arcobaleno ».

c) *Scritti di scienza filologica, filosofica e storica* :

« Della Logica », « Della sintassi », ***Risálah fi dalálah al qadr.*** (*o qadar ?*) *àla l-tawhid.*

« Delle instituzioni della flessione, secondo la scuola del Greci » : Grammatica Greca in due trattati; — « Delle categorie », secondo l'opinione di TEMISTIO; — « *Cronaca del mondo* o Storia universale », della crezione, dei Profeti, i sovrani, le nazioni, i califfi e i re dell'Islám : comincia da ADAMO e discendenti, menziona i re d'Israele, i sovrani Greci e Bizantini; narra il sorgere dell'Islám, il regno delli Ommiadi e delli Abbásidi sino all'età sua, cioè sino ai giorni di MUTAWAKKIL.

— *Risalah*, o racconto autobiografico « delle prove e disgrazie che gl'incolsero. » — « Risposta allo scritto di 'Ali b. Yakya, che lo incitava ad abbracciare l'Islam » (Trattasi probabilmente di 'A. b. Y. al munaggim « l'astrologo », padre di un IBN AL NADÍM, che viveva sotto al MUNTASIR.)

— Del conseguire la verità in fatto di religioni (*? K. fi idrák haqiqah al adyán.*)

Fonti :

USAYBI'AH I, pag. 184-200;
QIFTI, pag. 171-177;
FIHRIST, pag. 294-295;
LECLERC, I, pag. 139-152;
KHALLIKAN ed. WÜSTENFELD, no. 208;
WÜSTENFELD *Aertze* no. 69;
SIMON, *Sieben Bücher Anathomie des Galen;*
Encyclop. de l'Islam, II 357, ecc. ecc.;
G. BERGSTRAESSER, *Hunayn Ibn Ishák und seine Schule;*
H. SUTER, *Mathematiker und Astronomen der Araber*, no. 44.

(*Roma.*) GIUSEPPE GABRIELI.

Maslama al-Majrîṭî and the Rutbatu'l-Ḥakîm

The *Rutbatu'l-Ḥakim* or « Sage's Step » is one of the most important sources for the history of the development of chemistry in Arabic Spain. I have not hitherto been able to make a properly critical study of the text, although I hope to undertake this in the near future, but there are many problems and points of interest in connection with the *Rutba* which can profitably be considered independently, and with some of these I propose to deal. In view of the fact that it was from Spanish Islam that chemistry was transmitted to Europe, the necessity for a thorough study of those works on chemistry, by Andalusian Arabs, which have been preserved to us, will be apparent. Unfortunately such works are few in number, so that it will be needful to study those which we do possess very closely. The present article is to be regarded as preliminary only, but it is hoped that the information and discussion it contains will prove of use to those who pursue further researches on the subject.

1. *Codices.* Six manuscripts of the work are known, five of which are mentioned by BROCKELMANN (1). Of these, two are in the Bibliothèque Nationale at Paris, MSS. *Arabe* 2612 and 2613. The first (ancien fonds 973) is a paper volume of the sixteenth century, while the second (supplément 1078) — also paper — is of the seventeenth. Two more are preserved in libraries at Constantinople (Defteri kutubkâne'i Râġib Pâšâ, Stambul, 1310 A. H., No. 963, 5, and Nûr Osmânije kutubkkâne defteri, Stambul, No. 3623), and one in the Royal Library (formerly Khedivial Library) at Cairo (Cat. of the Khedivial Library, 1306-9, vol. V, No. 381). The sixth, which is in my possession, is an accurate modern copy of the last, and is the one which I have employed for purposes of this article. There appears to have been a seventh at St. Petersburg (2).

2. *Author.* The problem of the authorship of the Rutba is extremely puzzling and presents some extraordinary features. In this

(1) *Gesch. d. arab. Litteratur*, I, 243.
(2) *Congress of Orientalists*, Leyden, 1883, II, 285.

connection I would draw attention to a posthumous memoir of the learned Orientalist Dozy, published in 1883 by de Goeje, which seems to have escaped general notice (3). The author of the *Rutba* undoubtedly wrote a second book on somewhat similar lines, called *Ghâ'iatu'l-Ḥakîm* or « The Sage's Limit ». This work exists in numerous MSS. (4) and deals mainly with magic; as Dozy has pointed out in the memoir to which reference has already been made, it contains much material of great value for this history of the Sabians. It will be found that the *Ghâ'ia* is said to have been written immediately after the completion of the *Rutba*, so that the question of authorship involves them both.

All the manuscripts of both works agree in naming as author the celebrated astronomer and mathematician Abu'l-Qâsim Maslama ibn Aḥmad al-Majrîtî, who flourished in Spain under Al-Ḥakam II (961-976). It will therefore be necessary for us to examine briefly the material available for the biography of this scholar, but it should be at once noted that in neither work does the author name himself, so that the ascription of them to Al-Majrîtî must have been made by another person — whether rightly or wrongly we may perhaps be enabled to judge by the evidence adduced below.

The earliest authority we have for the death of Al-Majrîtî is Abul'l-Qasim Khalaf ibn 'Abdu'lmalik ibn Bashkual (1101-1183), who gives the date as Dhu'l-Qa'da 395 A. H. (1004 A. D.), or « according to Ibn Ḥayyân, 397, at the beginning of the *Fitna* » (*i. e.*, the disturbances which led to the fall of the 'Omayyads). Al-Qiftî (5) says that Maslama al-Majrîtî died in 198, and Ibn Abî Uṣaibi'a (6) follows him, while Ḥajjî Khalîfa gives 395. Thus the authorities all agree fairly closely, and it seems certain that the famous mathematician of Arabic Spain died between 195 and 198 A. H. (1004-1007 A. D.). His fame as an astronomer is well known, and his work in this field has already been fully described by Suter and others, so that no account of it is necessary here. According to Ibn Bashkual he was also learned in the science of division of inheritances (7), but it is a remarkable fact that none of his early

(3) See reference 2. I have made full use of this memoir the present article.
(4) Brockelmann, *loc. cit.*
(5) *Ta'rîkh al-Ḥukamâ'.*
(6) *Tabaqâtu l-Aṭibba.*
(7) *Wa kâna 'âliman bi'l-farâ'iḍ.*

biographers suggests that he was at all interested in alchemy, nor is any mention made of the *Rutba* or the *Ghâ'ia* in the list of works they ascribe to him.

That he was in some way connected with the *Letters* of the « Brethren of Purity » is certain, and it is common knowledge that in many cases the actual authorship of the *Letters* has been ascribed to him. On this queston FLÜGEL wrote (8): « Um aber die Nennung des MAǦARÎṬÎ als Verfasser in den erwähnten Exemplaren auf ihren wahren Werth zurückzuführen, dürfen wir als sicher annehmen, entweder dass MAǦARÎṬÎ unter demselben Titel ein ähnliches encyclopädisches Werk schrieb, oder, was ich glaube, dass er die echten Abhandlungen mit mehr oder weniger Veränderungen neu redigirte, diese Redaction als sein Werk verbreitete, ohne dessen Ursprung näher anzugeben, und sich so den Ruhm, der wahre Verfasser dieser Abhandlungen zu sein, zueignete. Darauf deutet auch H. CHALFA (III, S. 460, Nr. 6439) hin, wenn er zwar dem im J. 395 (1004-5), nach Andern 398 gestorbenen MAǦARÎṬÎ Abhandlungen desselben Titels zuschreibt, jedoch bemerkt, es sei das eine ausgetauschte d. h. veränderte und daher abweichende, nach dem Muster der echten Abhandlungen der aufrichtigen Brüder hergestellte Redaction oder Abschrift. »

It thus seems probable that AL-MAJRÎṬÎ made a new recension of the *Letters*, and that either he or his pupil AL-KERMANI first introduced them into Spain. In the Cairo MS. of the *Rutba* the following relevant passage occurs : « I have already presented to you a letter among the collection of philosophical letters (meaning by that the whole of the letters, that is the letters known as the *Ikhwânu's-Ṣafâ wa Khullânu'l-Wafâ*), in which you will see that I have included an account of the minerals very similar to that which I give here. I have, indeed, composed this book to take the place of those letters in their entirety, so that I will now begin to give, to the best of my ability, an account of the method of procedure with animals according to the description given by the folk of the art of *Al-Kîmia'*, after which I will describe the way of dealing with minerals and the rules which must be observed herein. I shall, however, neglect to speak about plants, since that is done in a well known letter of the Collection, and no philosopher needs it unless he

(8 Z.D.M.G., XIII (1859), 25.

be a physician. Anyone who wishes to know about plants should read the appropriate passage in the *Letters*, in order that he may benefit thereby, if Allâh be willing! »

The *Letters* are referred to in several other passages in the book, while in marginal notes by the copyist in the Cairo MS. is to be found in two places. « the author of this book says in the *Ikhwânu's-Ṣafâ*. . . » It thus appears to me that FLÜGEL's suggestion that AL-MAJRÎṬÎ made a new recension of the *Letters* has much to recommend it, and it would even seem possible that he may have been the original author of the sections on animals, plants and minerals. We shall see, however, that this assumption has its difficulties.

In the first place, there is serious uncertainty as to the date of the composition of the *Rutba*. In the Cairo MS., and in the Paris MS. 2613, the author says that he began to compile the *Rutba* in 439 A. H. and finished it in 442. If this date is accepted as correct, it is obvious that the author could not have been AL-MAJRÎṬÎ, since his death is given as occuring in 398 at latest. In the Paris MS. 2612, however, the date of composition of the *Rutba* is put back a century, namely to 339-342, while most, if not all, of the MSS. of the *Ghâ'ia* agree in making the author say that he composed the latter work, after the completion of the *Rutba*, in 342-348. We are here confronted with two difficulties, for (*a*) if AL-MAJRÎṬÎ was the author, he survived the compilation of these works by nearly half a century, the improbability of which has been pointed out by both DE GOEJE (9) and the writer of the catalogue of the Leyden library (10); and (*b*) the *Letters* of the « Brethren of Purity » were written, according to FLÜGEL, about the year 360 A.H. and therefore could not have been mentioned in books written in 339-348.

To enable us to decide which of the two dates is the more probable we may turn to internal evidence afforded by the *Rutba*. Of prime importance here is the statement made by the author in the preface that he was led to write the book on account of the ignorance of his contemporaries and the lamentable state into which learning had fallen since the outbreak of the *fitna* in Spain. In DE GOEJE's article attention is drawn to the fact that Spanish-Arab writers constantly use the term *fitna* in reference to the civil strife which finally led to the overthrow of the 'Omayyad dynasty, the beginning of which

(9) *Loc. cit.*

(10) Quoted by de GOEJE, *loc. cit.*

turmoil occured in 1009 A.D., *i. e.*, two years after the latest date given for the death of AL MAJRÎṬÎ. This would indicate (i) that AL-MAJRÎṬÎ was not the author of the *Rutba* and the *Ghâ'ia*, and (ii) that 439-448 is the correct date of composition of these works. Additional support of this view is furnished by an interpolation in the St. Petersburg MS. of the *Rutba* (11), which says, « and he (*i. e.*, the author) died in 469 » A. H.

On the other hand, the author of the *Rutba* mentions no chemist or any other writer later than AL-RÂZÎ (died 923 or 932), and in talking of JABIR IBN ḤAYYAN (whom he considered the greatest genius of Islâm as far as chemistry was concerned), he says « more than 150 years separate him from me ». Now JÂBIR was a pupil of JA'FAR AL-ṢÂDIQ (died 765), and probably died somewhere about 800 A. D. Passage of 150 years would bring the date to 950 A. D. or 339 A. H., which corresponds exactly to the earlier of the two dates mentioned in MSS. of the *Rutba*. I agree, however, with DE GOEJE, who remarks that probably the author was mistaken as to the date at which JABIR died. That this is likely is shown by a passage in which the transmission of alchemy to Islâm is said to have been from KHÂLID IBN YAZÎD to IBN AL-WAHSHIYYA, thence to JA'FAR AL-ṢÂDIQ and from him to JÂBIR IBN ḤAYYÂN. The insertion of IBN AL WAHSHIYYA between KHÂLID and JA'FAR shows that the writer was not aware of the fact that JA'FAR died in 765 A. D., and that his death preceded that of IBN AL-WAHSHIYYA by about a century and a half. This anachronism obviously invalidates the argument that the *Rutba* must have been written in 339-342, since if the author was mistaken as to the time of IBN AL-WAHSHIYYA we have no reason to suppose that he was any better informed on that of JÂBIR IBN ḤAYYÂN.

There is, indeed, an impenetrable mystery around the *Rutba* and the *Ghâ'ia*. The internal evidence, such as it is, all points to the earlier of the two dates as the correct one, with the single but insurmountable exception of the definite statement that the former work was written « *after the fitna* ». The chief authorities quoted by the author are JÂBIR and AL RAZÎ, and so far as I have been able to discover, no one of later date than the latter is mentioned. ABÛ MA'SHAR (died 885 A. D.) is referred to on one occasion, while the Egyptian alchemist and Sûfî, DHU'N-NÛN, is occasionally quoted; two men about

(11) *Ibid*.

whom I have been unable to find any information are also mentioned, viz., Ibn Abî al-Nûf and Ja'far al-Basrî, but there is no indication that the author was cognisant of the writings of Ibn Sînâ (980-1036/7). This last point I consider to be of importance, as it is unlikely (*a*) that a Muslim writing in 1047-1050 would be unacquainted with Ibn Sînâ's works, and (*b*) that in the event of his knowing them he should refrain from quoting them, especially on the question of the « reality of alchemy », which is discussed in the *Rutba*.

In the course of my study of Arabic alchemical MSS., the earliest ascription of the *Rutba* and the *Ghâ'ia* to Al-Majrîtî which I have met with is that of Aidamir al-Jildakî (died at Cairo shortly after 1360 A. D.), who adds to these two a *Kitâb al-Aḥjâr* or *Mineralogy* of which a fragmentary MS. is preserved in the Bodleian (MS. Marsh 452). Ibn Khaldûn mentions the *Rutba* and *Ghâ'ia* frequently, and gives Al-Majrîṭî as their author, later writers naturally following him. There appears to be no trace of the other books which the author of the *Rutba* claims to have written, the chief of which was entitled « *Classes of the Arab Philosophers* ».

We are therefore forced to leave the problem in an unsatisfactory state, and must be content with summing up the available evidence as follows.

i. Although the *Rutba* is invariably assigned to Al-Majrîṭî by Al-Jildakî, Ibn Khaldûn and later writers, the author does not name himself and therefore this ascription is open to doubt.

ii. Al-Majrîṭî died before the *fitna*; the *Rutba* was written after the *fitna*. If « fitna » is to be taken in its usual sense, Al-Majrîṭî cannot be the author, as he died in or before 1007, while the *fitna* broke out in 1009.

iii. The MSS. of the *Rutba* give two different dates for its compilation (*a*) 339-342 A. H and (*b*) 439-442. If *b* is correct, Al-Majrîṭî obviously could not have written the work; *a* is incompatible with the statement made in ii, *viz.* that the book was composed after the *fitna* had broken out.

iv. The author of the *Rutba* claims tot have lived more than 150 years after Jâbir, who died about 800 A. D. as far as we can ascertain. This supports the date 339-342 A. H. (*a* above), but the author may have been mistaken as to the time at which Jâbir flourished, as he certainly was mistaken about Ibn al-Wahshiyya.

v. References to the *Ikhwânu's-Ṣafâ* may be later interpolations; they are in any case not in agreement with the date 339-342.

vi. The only other point of internal evidence incompatible with the date 339-342 is that mentioned in (ii) above. The latest author mentioned in the *Rutba* is Al-Râzî (died 923 or 932).

Personally I am inclined to accept the date 439-443 as the correct one, and to regard the ascription of the *Rutba* and *Ghâ'ia* to Al-Majrîṭî as false. The crucial point seems to me to be the mention of the *fitna*, while the addition of the date of the author's death, in the St. Petersburg MS., is confirmatory of this view although of course it is not authoritative. Dozy and de Goeje arrived at the same conclusion, which indeed is almost inevitable. Against it we have to consider the earlier date given in several MSS. and the fact that the *Ghâ'ia* invariably (I believe) is given as written in 342-348; there is, however, the significant absence of mention of Avicenna. It will thus be readily perceived that acceptance of Dozy and de Goeje's conclusion is not altogether satisfying, and the subject is one which would probably repay closer investigation.

3. *Nature of the book.*

The *Rutba* is divided into a preface and four *maqâlas*. Each *maqâla* consists of a number of chapters or *fuṣûl*. *Maqâla* I deals with a recommended selection of books of the « ancients and moderns », with suggestions on the manner of reading them and instructions on how to proceed if these books are not available. *Maqâla* II is on the philosopher's stone, and *maqâla* III is concerned with the Elixir, while *maqâla* IV is a disquisition on the dark sayings of the experts, and the way of unravelling them.

Maqâla I. The author says that geometry is as the foundation of alchemy; if the foundation is firmly laid the structure which is built upon it will also be firm. Of equal importance with geometry is arithmetic, the science of numbers. For this mathematical training the would-be chemist should read Euclid. Astronomy is also necessary, in order that one may know the nature of things, and here the *Almagest* of Ptolemy is recommended. Logic should be studied in the book which Al-Kindi translated from Aristotle.

Next, the study of the natural sciences must be undertaken. The chief authors are Aristotle, Democritus, Hermes and Apollonius of Tyana; the last three of these may be dispensed with if one has Aristotle's books *De Cœlo et Mundo, De Generatione et Corruptione, Meteorologica* and *Physica Auscultatio.* If it is possible to obtain

them, the *De Anima, De Causis and De Spiritu* are of value, but not indispensable as are the four preceding ones. In the unfortunate event of ARISTOTLE being unavailable the student must use APOLLONIUS' *Qânûn al-'Ilm*, and take it for his guide — it will prove sufficient for his needs.

The *Rutba*, however, is intended to render the reader independent of most books. It was written because the author found that his contemporaries knew very little of the metallic bodies — not knowing even, the spirit thereof from the body, let alone their reactions with one another and their properties in respect to malleability and ductility. Yet these things were well known to the common people.

It is necessary for the chemist to practise his hand in operation, his eye in examination, and his mind in reflection over these matters. Then let him consult also the authorities such as HERMES, DEMOCRITUS, OSTANES, AGATHODEMON, MARY THE COPT, ARISTOTLE, PLATO and ZOSIMUS, passing from these to JABIR IBN ḤAYYÂN AL-ṢÛFÎ AL-TÛSÎ, and MUHAMMAD IBN ZAKARIYYA AL-RAZÎ.

The author then proceeds to discuss the « Art » itself. First, he says, think whether this art is (I) necessarily existent, or (II) necessarily non-existent, or (III) conceivable. If it is (I) then why is it so obscure? If (II), then why do people seek it? If (III), then think whether it is to be conceived of as in category (I) or category (II). If you decide it is in (I) then search for it, for it is attainable, but if in (II), then cease reading the books dealing with it, for they must be vain, and the search for vain things should be left to the people of ignorance.

The Art is, however, possible, and if you wish to investigate the question of its truth or falsity then examine the book of AL-RÂZÎ's entitled *Kitâb al-Ithbât* (12), which deals with this very question. Anyhow, as regards proof, the best indication of the truth of the possibility of transmutation is its actual accomplishment. For this, experiment with the metallic bodies under the action of fire. Fuse two metals together, for example, and observe the result. If the product differs from the original substances, then a transmutation must have occured and so the Art is « necessarily existent » (*wâjibatun*).

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(12) Probably the book called *Die Sicherstellung der Kunst* mentioned by RUSKA in *Isis*, V (1923) 47.

The imperfect metals are really gold infected with various « accidental qualities » Thus JĀBIR says that all metals would in their mines become gold were it not for the fact that accidental qualities are acquired by them, and they thus fall short of the level of gold. Nevertheless, the only sure proof of the possibility of transmutation is actual demonstration.

Finally the author advances reasons for supposing that a knowledge of talismans is an aid in alchemy.

Maqâla II. The nature of the Elixir is first discussed, and the author states that there is only one Elixir, in spite of what the 'modern' Arab philosophers say. It is threefold in power, these powers corresponding to spirit, soul and body. According to AL-RÂZĪ, in his *Book on the Elixir* (13), it is a substance of four equivalent natures and three equivalent powers; it is insoluble in water and incombustible. It is of two kinds, the red and the white. The Red Elixir is hot and dry, resembling gold, while the white Elixir resembles silver; they indeed contain gold and silver respectively — a view with which the author of the *Rutba* disagrees.

He who desires to change copper into silver or silver into gold, or to « strengthen » tin or coagulate mercury must necessarily first enquire what silver needs to become converted into gold, copper to become silver, tin to withstand the heat of the furnace, and mercury to become coagulated. If he knows this, then he knows the properties of the substance necessary to bring about these changes, *viz.*, it must be able to colour silver yellow, to whiten copper and to « strengthen » tin. Hence it is clear that these three powers must all be gathered together in the Elixir.

Transmutation is possible since although the metals differ from one another, their prime matter is the same throughout.

On the nature of the Elixir JĀBIR is quoted, who says that the philosopher's stone is unique, and contains the tinctorial powers essentially and not as accidental qualities.

Maqâla III. The author remarks that Nature always behaves in an invariable way, never doing the same thing in different ways. The chemist must therefore strive to follow Nature, whose servant indeed he is, like the physician. The latter diagnoses the complaint and administers a remedy, but it is Nature who acts.

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(13) RUSKA (*loc. cit.*) mentions *Das Buch des Iksirs.*

Quotations are made from AL-RÂZÎ's book entitled *Kitâb al-Tadbir*, *Kitâb al-Ḥaja*, and *Kitâb 'ilal al-Ma'âdin* (14) and from JÂBIR's *Kitâb al-Arkân*, while reference is made to ABÛ MA'SHAR's *Kitâb al-Ulûf*, *etc.* A long and rather rambling account of the genesis of metals is included, in which the sulphur-mercury theory is definitely formulated. The author's experience with mercury is noteworthy as showing that he carried out his own exhortation to be assiduous in practical work : « I took natural quivering mercury, free from impurity, and placed it in a glass vessel shaped like an egg. This I put inside another vessel like a cooking-pot and set the whole apparatus over an extremely gentle fire. The outer pot was then in such a degree of heat that I could bear my hand upon it. I heated the apparatus day and night for 4 days, after which I opened it. I found that the mercury (the original weight of which was 1/4 lb.) had been completely converted into a red powder, soft to the touch, the weight remaining as it was originally. »

This early and accurate observation of the oxidation of mercury — an experiment which, in the hands of LAVOISIER, led to such epoch-making developments in the eighteenth century — is of no little interest.

Maqâla IV. This *maqâla* deals chiefly with the 'dark sayings' of the alchemists. Reference is made to ZOZIMUS, DEMOCRITUS, MARY THE COPT and PLATO, and passages from KHÂLID IBN YAZÎD, DHU'N-NÛN, IBN AL-WAHSHIYYA and the book entitled *Kitâb al-Mulâgham* (15) (probably by JÂBIR IBN ḤAYYÂN) taken and discussed. A great deal of material ascribed to ZOSIMUS and his woman student AMNUTHASIA (THEOSEBIA, etc.) is treated at some length but presents no features of special interest; it is mostly incomprehensible or vague.

The author's remarks about JÂBIR IBN ḤAYYÂN are, however, important. He says that the 'Umayyad prince KHÂLID IBN YAZÎD was the first to have books on alchemy translated into Arabic, and that alchemy passed next to IBN AL-WAHSHIYYA (an anachronism which has already been noted). Thence it passed to JA'FAR AL-ṢÂDIQ, who was the teacher of JÂBIR IBN ḤAYYÂN. The author of the *Rutba* says that he knows of no chemist more skiful or eloquent than JÂBIR, « and although he and I are separated by more than 150 years, yet

(14) RUSKA (*loc. cit.*) mentions *Die Ursachen der Mineralien.*

(15) See my Bibliography of the works of JĀBIR IBN ḤAYYĀN, *Proc. Roy. Soc. Med.*, Oct., 1923

I regard myself as a true pupil of his on account of my great admiration for his works, all of which I have gathered together... and of which I have given the names in my *History of the Arabian Philosophers* ».

JÂBIR, he says, struck out a new line and cut himself off from the old tradition. He found that most people did not believe in the possibility of obtaining the elixir, while those who did believe were of the most ignorant type. He therefore decided to give instructions of a more practical kind. If he had written in the same style as the 'ancients', his books would have been cast aside as worthless, and the truth of the Art denied altogether. For the ancients wrote for people who had a good knowledge of natural science and realised that Nature has her secrets; they therefore did not object to books written in an obscure style since they knew that the Art was true. In those days, philosophers had no need to encourage people to undertake the study of the Art, nor to prove it in any other way than by verbal argument JÂBIR's way, however was different, and is better than that of KHÂLID — who followed the ancients — for he (KHÂLID) merely wished to show men that he himself was accomplished in alchemy. JÂBIR considered that it was useless to follow the old traditional path, as he would get no credence, so he wrote practical books and expounded them by clear demonstration; anyone who pleased could get ocular evidence of the truth of the statements they made. He would not say in a book that, for example, copper may be converted into silver or silver into gold, since that would have laid him open to ridicule, and people would have said to him, « If what you say is true, you have done evilly, for your book will get into wrong hands; if, on the other hand, it is false, again you have done evilly, for you have maintained the false to be true ». So he wrote books of such a fashion that every chapter ends with the words, « Project some of this substance upon so much copper and you will get silver », or the like. Thus those who were ignorant of the Art would be attracted, whereas if he had plainly stated the fact of transmutation they would simply have scoffed. Yet it is clear that transmutation is hinted at in the above example, for it is to be noted that he never instructs the projection of one part of the substance upon less than 30 parts of copper, so that even if all the projected substance were silver, transmutation must obviously have occurred if the product was entirely silver.

The great value of JÂBIR's works, he says, lies in this very fact of their being practical, for if a man reads of the process first and then carries it out in practice, he will naturally believe in the truth of the Art. As a matter of fact, all the various operations which JÂBIR describes, such as calcination, are in reality transmutations of one substance into another, so that by performing them the sceptic may gradually be led to belief. The theory of the Art is, indeed, difficult, but its practice is easy.

The author then turns to a consideration of sulphur, mercury, marcasite, tutia, magnesia, talc, lazward, vitriols, alums, and other necessary substances, after which he gives an account of the purification of gold and silver, the chief points of which are as follows :

Silver alloyed with lead may be separated from the latter by placing it in a cupel made from bones (called the « dog's head » or commonly the *kûraja;* it is a crucible made from burnt bones) and fusing it by means of a strong fire. The lead is removed and absorbed by the cupel and the silver is left pure and free from base metal. Silver may be separated from copper in the cupel by the continual addition of lead; after a time the silver appears in a state of purity.

Gold may be purified from silver and copper in two ways. From copper alone it may be refined by the method used to purify silver from copper, namely, cupellation with addition of lead. If it is so desired, sulphur may be added as well; this burns the copper and the gold remains pure. Gold may be purified from lead by the method used to refine silver from lead.

The purification of gold from silver may be carried out in two ways, one by means of « stones » and the other by means of salts. The former method is as follows : the gold alloyed with silver is beaten out into thin leaves and these are placed on a bed of hæmatite and salt and covered with more of the same mixture followed by a layer of red clay. The whole is then heated in the oven known to men of science as the « refining-furnace », when the silver is absorbed by the earthy matter and the gold leaves are left pure, containing nothing but the most refined gold.

This operation may also be carried out in a similar way by using alum and salt or by means of old baked clay. The clay is finely powdered and mixed with an equal amount of salt and the two well powdered again. The mixture is then spread in a layer on a layer of red clay. A gold leaf is next added, followed by another

layer of the mixture of clay and salt, and so on until all the gold has been added. A covering layer of clay and sand is then placed on the top and the whole strongly heated, when the gold is purified and extracted from the silver. The silver may be recovered merely by the addition of mercury to the earthy residue. The mercury thickens and coagulates until it becomes like dough. At this stage it is placed in a crucible over the fire and the mercury then volatilises away, leaving the silver.

Gold may also be separated from silver in the same way that it is separated from copper. The gold-silver alloy is mixed with a little copper and the mixture fused, with addition of red sulphur from time to time. The gold refines away from the silver and is left pure. The former method, however, is the more efficient.

The book closes with the usual admonition to the reader, but, as already mentioned, the conclusion gives no clue to the identity of the author.

E. J. Holmyard.

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Walton
A medieval aquiculturist

Sir William A. Herdman's interesting work on the Founders of Oceanography, 1923 (1), contains a reference (on p. 288) to an Irishman called Walton who is said to have invented a remarkable system of mussel-culture about the middle of the XIII century. Upon enquiry as to his source of information, Sir William kindly referred me to Coste's (2) « Voyage d'exploration sur le littoral de la France et de l'Italie. Rapport à M. le Ministre de l'Agriculture... sur les industries de Comacchio, du Lac Fusaro, de Marennes et de l'Anse de l'Aiguillon », a sumptuous folio published by the Imprimerie Impériale in 1855. Coste's historical information is derived from another work which I have been unable to obtain (though I wrote to the main American libraries), the « Théâtre des Merveilles de l'Industrie humaine, par D. T. V. T., gentilhomme ordinaire de la chambre du Roi », Rouen 1598.

Coste's account (3) is as follows :

« Dans l'anse de l'Aiguillon, à quelques kilomètres de la Rochelle, sur l'immense et stérile vasière qui forme le fond de cette baie fangeuse, où la population du littoral n'avait trouvé jusque-là aucune ressource, un pauvre Irlandais, que la tempête jeta sur ce rivage, créa, il y a bientôt huit siècles, une industrie dont le produit fait vivre aujourd'hui dans l'aisance les trois mille habitants des communes d'Esnandes, de Marsilly, de Charron, auxquelles il légua cet héritage, comme si la Providence eût voulu lui laisser la consolation de payer la généreuse hospitalité qui l'avait accueilli dans son infortune. Ce fut vers la fin de l'année 1235 qu'arriva l'événement qui devait ouvrir à la contrée l'ère de la prospérité, et y faire succéder l'abondance à la misère.

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(1) Reviewed in *Isis*, VI, 91-95.

(2) Jean Jacques Marie Cyprien Victor Coste (1807-1873), membre de l'Institut, professeur au Museum, puis au Collège de France. Vers la fin de sa vie il s'occupa beaucoup de pisciculture.

(3) P. 148-152, with two plates.

« Une barque, chargée de moutons et montée par trois hommes d'équipage, vint, chassée des côtes d'Irlande par un violent coup de vent nord-ouest, se briser contre les rochers de la pointe de l'Escale, à une demi-lieue du port d'Esnandes. Equipage et marchandise, tout aurait été inévitablement enseveli dans les flots, si les pêcheurs du littoral ne se fussent empressés de porter secours à l'embarcation en détresse. Mais, malgré tous leurs efforts, ils ne réussirent à sauver que l'un des trois hommes dont se composait l'équipage : cet homme en était le patron; il se nommait WALTON, et devint le fondateur du premier *bouchot;* invention merveilleuse, dont les fruits font depuis longtemps la richesse d'une province, et dont l'application à d'autres rivages inscrira un jour le nom encore obscur de son auteur parmi ceux des plus utiles bienfaiteurs de l'humanité.

« Exilé désormais sur cette plage, où il ne lui restait, pour toute fortune, que quelques moutons échappés au naufrage, et dont la race, croisée plus tard avec celle du pays, a formé cette belle variété connue dans la Vendée sous le nom de *mouton de marais,* WALTON appliqua son génie à se créer, par le travail, des moyens d'existence, et à se rendre utile dans sa nouvelle patrie. Il résolut donc de parcourir en tous sens le vaste lac de boue qu'il avait sous les yeux, et de voir s'il n'offrirait pas quelque ressource à son industrie. Mais, pour atteindre ce but, il était obligé de marcher, à mer basse, sur cette boue fluide, qui se dérobait partout sous ses pas, et mettait obstacle à la réalisation de son dessein.

« En présence de cette première et bien sérieuse difficulté, l'idée lui vint de construire une pirogue de la plus ingénieuse simplicité, à l'aide de laquelle, sans autre impulsion que celle du pied, il glissa sur la vasière avec la rapidité d'un cheval au trot, visitant ainsi les diverses localités et pouvant, grâce au concours de cet instrument nouveau, se livrer désormais à toutes les entreprises qu'il lui paraîtrait utile de tenter. Les oiseaux de mer et de rivage qui rasent la surface de l'eau pendant l'obscurité lui parurent s'y rencontrer en assez grand nombre pour y devenir l'objet d'un commerce lucratif si on réussissait à leur tendre des pièges convenablement organisés. Il appliqua à cet usage une espèce particulière de filet, importée par lui, et désignée sous le nom de *filet d'allouret* ou filet de nuit.

« Cette immense toile, à deux mailles inégales,longue de trois à quatre cents mètres, sur trois de hauteur, fixée à de longs piquets enfoncés d'un mètre dans la vase, fut tendue, par ses soins, au-dessus du niveau de la pleine mer, comme un rideau, dans les bourses

duquel s'engouffraient tous les volatiles qui en croisaient la direction.

« Walton n'eut pas longtemps à exercer cette industrie sans s'apercevoir que la progéniture des moules de la côte venait s'attacher à la portion submergée des piquets qui soutenaient son allouret, et sans se convaincre que ces moules, ainsi suspendues à une certaine hauteur au-dessus de la vase, y prenaient une plus grande taille, un meilleur goût que celles qui vivaient à l'état sauvage, ou qui étaient ensevelies sous le limon. Cette découverte fut pour lui une véritable révélation. Il multiplia les points d'attache en plantant de nouveaux piquets, et, comme les premiers, ceux-ci se chargèrent de jeunes moules, qui augmentèrent sa récolte en proportion du nombre de supports qu'il offrit à ses colonies naissantes. Il ne pouvait donc plus y avoir de doute, après le succès d'une telle expérience : la progéniture des moules sauvages était susceptible d'être recueillie et élevée sur ces reposoirs artificiels, de manière à donner à cette culture les proportions d'une grande exploitation. C'est à cette œuvre importante qu'il consacra désormais tous ses efforts.

« Les pratiques qu'il institua furent si heureusment appropriées aux besoins permanents de la nouvelle industrie, qu'après bientôt huit siècles elles servent encore de règle aux populations dont elles sont devenues le riche patrimoine. Il semble qu'en s'appliquant à cette entreprise, non seulement il avait la conscience du service qu'il rendait à ses contemporains, mais le désir que leurs descendants en conservassent le souvenir, car il donna aux appareils qu'il inventa la forme d'un double V, lettre initiale de son nom, comme s'il eût voulu que son chiffre fût inscrit sur tous les points de cette vasière fertilisée par son génie, en attendant sans doute que la reconnaissance publique élevât un monument à la mémoire du fondateur. Voici comment il construisit le premier établissement, sur le modèle duquel sont édifiés encore aujourd'hui les quatre cent quatre-vingt-dix bouchots qui couvrent la moitié de l'anse de l'Aiguillon.

« Ce fut, si l'on s'en rapporte à un document publié vers la fin du xvi[e] siècle [le livre de 1598, cité plus haut], ce fut en 1246, dix années après son naufrage, que Walton aurait procédé à cette construction. Les piquets isolés dont il s'était jusque-là servi ayant été, à diverses reprises, arrachés par la tempête, couchés par le choc des barques, ou des blocs de glace, et ces accidents lui ayant fait perdre en un seul jour le fruit de plusieurs mois de travail, la nécessité le contraignit d'avoir recours à des appareils plus complexes, plus

solidement établis, et qui, en même temps qu'une grande solidité, offriraient de vastes surfaces pour recevoir le *naissain*, et peu de prise à l'action de la lame. En conséquence, il dessina, au niveau des basses marées, suivant une ligne supposée aller du château d'Esnandes au château de Charron, là où maintenant il existe de vastes prairies, un double V dont le sommet, légèrement entre-bâillé, était tourné vers la mer, et dont les côtés, prolongés d'environ deux cents mètres vers le rivage, s'écartaient de manière à ouvrir un angle d'à peu près quarante-cinq degrés. Le long de chacun des côtés de cet angle, il planta, à la distance de deux ou trois pieds les uns des autres, de forts pieux, de dix à douze pieds de hauteur, qu'il enfonça à moitié dans la vase, dont il clayonna les intervalles avec des fascines ou branchages, afin d'en former de solides palissades, capables de résister à l'effort des flots. Au sommet de l'angle représenté par ces longues ailes, il laissa, entre les panneaux, un écartement de trois ou quatre pieds, pour y adapter des engins destinés à recevoir les poissons qui, à mer descendante, suivraient la voie bordée par cette double haie; se ménageant, par cette heureuse combinaison, une double ressource; car son établissement était à la fois une moulière artificielle et une pêcherie. Aussi voit-on encore de nos jours les *boucholeurs*, fidèles à toutes les pratiques dont WALTON leur a laissé l'exemple, partir dans leurs *acons* avant que la mer ne découvre, venir s'arrêter derrière le sommet entr'ouvert de chaque appareil, munis d'un filet dit *avenau*, s'y livrer à la pêche jusqu'à ce que leur nacelle reste à sec, et qu'ils puissent ensuite la charger de coquillages, et la ramener au port en glissant sur la vase. »

COSTE quotes two other sources (1) : MERCIER DUPATY. Mémoire sur les bouchots à moules. ***Recueil de l'Académie royale de la Rochelle***, 1752; CHARLES d'ORBIGNY. Mémoire sur les bouchots à moules des communes d'Esnandes et de Charron. ***Annales de la Société d'agriculture de la Rochelle***, 1846. However, the information on WALTON is ultimately derived from the ***Théâtre des merveilles***, a work published more than three and a half centuries after the events described. One has thus good reason to be sceptical if not with regard to the events themselves (2), at least with regard to their dating. Is that dating not due to a misprint in D. T. V. T. 's book for instance ? Is it substantiated by archival documents ?

(1) Both unavailable to me.

(2) Leaving out of the question some of the romantic interpretations.

I have taken many pains to find out who this WALTON was, all in vain. CHEVALIER does not mention him in his Répertoire, but this I hardly expected. I consulted various works dealing with the history and bibliography of La Rochelle, but was not more fortunate.

The purpose of this note is to obtain whatever information is available on this great man. Some antiquarian of La Rochelle might be induced to study the question, in which case I would be glad to publish the results of his investigations.

Incidentally who was this D. T. V. T. (1), gentilhomme ordinaire de la chambre du Roi ? His « Théâtre des merveilles de l'industrie humaine » may be a very interesting and valuable work and it would be worth while at any rate to examine it and give a brief account of it.

George SARTON.

Cambridge, Mass. Nov. 10, 1923.

(1) I found nothing in various works on Anonyms.

Incommincia vna practica molto bona et vtile a ciascbaduno chi vuole vsare larte vela mercha-dantia.chiamata vulgarmente larte ve labbacho.

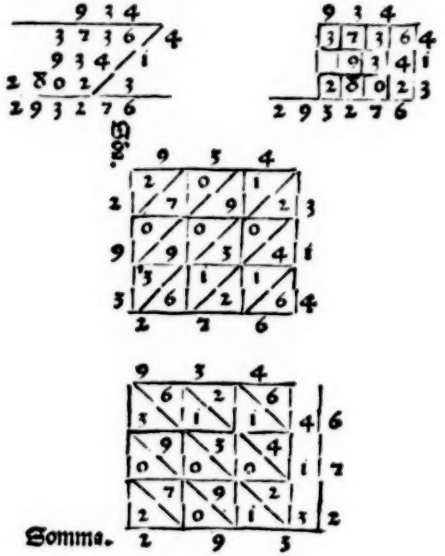
Pregato piu e piu volte da alchuni zouani a mi molto vilecissimi : li quali pretendeuano a douer volar fare la merchadantia:che per lozo amoze me piacesse affadigarme v no puocho:de vargli in scritto qualche fundamẽto circa larte de arismetrica:chiamata vulgarmente labbacho.Unde io constretto per amoz di lozo: et etiãdio ad vtilita di tutti chi pretendano a quella:se gondo la picola intelligentia del ingegno mio:ho deliberato se non in tuto:in parte tamẽ satisfare a lozo.acio che lozo virtuosi desideru vtile frutto re-ceuere posseano.In nome di dio adoncha : toglio per pricipio mio el ditto de algorismo cosi ducẽdo.

Ute quelle cose:che da la prima origine hano habuto producimẽto:per ratone de numero sono sta formade.E cosi come so-no:bano da fir cognosciude.Pero ne la cognitione de tute le cose:questa practica e necessaria . E per intrar nel ppolito mio:primo sapi lectore:che qn-to fa al propolito nostro:Numero e vna molti-tudine congregata ouero insembrada da molte vn-tade.et al meno da do vnitade.come e.2. el quale e lo primo e menoze numero:che se truoua.La vnitade e quella cosa : da la quale ogni cosa si dita vna.Segõdario sapi:che se truoua numeri de tre maniere.El primo se chiama numero simplice.al tro numero articulo . El terzo se chiama numero

The first page of the Treviso arithmetic (reduced).

Uoglio pero che tu intendi che sono alteri modi de molnplicare per scachiero:li quali laffaro al studi o tuo:mettendo li exempli soi solamente in forma. come porai vedere qui sotto

Oz togli de fare lo predi:to scachiero.3oe.3 i 4. fia.9 3 4.e nota de farlo per li quatro modi come qui da sotto.



A page from the Treviso arithmetic showing methods of multiplication.

The First Printed Arithmetic

(Treviso, 1478)

Introductory Note.

In spite of the fact that printing took its rise in the countries of the North, only a few years elapsed before Italy assumed a commanding position in the manufacture of books of various kinds. Her superior culture offered an immediate market for classical works, her religious supremacy encouraged the productions of clerical scholars, and her still dominating commerce favored the publication of books relating to mercantile affairs. The effect of this activity upon mathematics may be seen in the fact that from 1472 to 1480 there were 38 mathematical works printed in Italy, 63 in the next decade, and 100 in the next, with 13 of uncertain date between 1472 and 1500, making a total of 214 appearing in a period of less than thirty years (1).

Printing was introduced into Italy in 1464 by JUAN TURRECREMATA (2), abbot of the monastery of Subiaco, near Rome. The first book from an Italian press appeared in the following year (3), and thirteen years later the first printed arithmetic was published at Treviso, then a day's journey north of Venice. At present the traveler going from Venice to Feltre, where VITTORINO was born, or on to Belluno to begin his automobile journey to the Val d'Ampezzo, sees the five tall towers of Treviso an hour after taking his train. The town lies on the broad and fertile Venetian plain, and its position on the trade route from the Adriatic to the North gave

(1) RICCARDI, P., *Biblioteca Matematica Italiana*, Modena, 1893, parte seconda, XI, XV, seq.

(2) The family name was TORQUEMADA, of which this in the Latin form. He was a native of Valladolid.

(3) PUTNAM, G. H., *Books and their Makers*, New York, 1896-1897, vol. I, p. 404.

A page from the Treviso arithmetic showing methods of multiplication.

The first page of the Treviso arithmetic (reduced).

it considerable commercial importance in the fifteenth century. The various arithmetics of the earlier days make mention of it in connection with Padua, Venice, and other centers of trade, so that it is natural to expect that any textbook published there would be purely mercantile in character. That this arithmetic is of that nature will be seen from the translation of certain of the most interesting and characteristic portions given below; indeed the purely theoretical works of this period usually appeared at Paris rather than in the commercial towns of Italy, France, or Germany.

At least three printing establishments were opened at Treviso before 1500, namely, those of BERNARDO DE COLONIA (1477-78), JOHANNES REBEUS (1485), and one MANZOLO or MANZOLINO, the last of whom seems to have published this work (1). The author is also unknown, a fact not very surprising to any one who looks into Venetian history, a record where self-effacement is so universal. Mrs. OLIPHANT, in *The Makers of Venice*, calls attention to this characteristic feature in these words : « When BYRON swept with superficial yet brilliant eyes the rolls of Venetian history, what did he find for the uses of his verse ? Nothing but two old men, one condemned chiefly for his own fault, the other for his son's — remarkable chiefly for their misfortunes. » Indeed this great capital, for centuries the world's commercial and financial center, left from its Golden Age not only no great names in mathematics, but none in letters. The glory of the individual was absorbed in the glory of the State for a thousand years, and it is not improbable that to this charateristic of the Venetians is due the fact that the first printed arithmetic is an anonymous one. The book itself is exceedingly rare (2). The copy which has been used in preparing this partial translation belonged in the celebrated library collected by the Italian bibliophile MAFFEO PINELLI (3), who died in 1785.

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(1) Padre DOMENICO MARIA FEDERICI, in his *Memorie Trevigiane sulla Tipografia del secolo XV*, Venezia, 1805, p. 73, has given the results of a careful investigation of this question. He says : « In questo medesimo anno pubblicò il MANZOLO = Abbaco... Lo stampatore non è segnato, ma di certo fu il MANZOLINO. »

(2) The most critical study that has been made of the work is that of Prince BONCOMPAGNI, *Atti dell'Accademia Pontificia de' Nuovi Lincei*, Roma, 1862-1863, tomo XVI.

(3) La libreria già raccolto con grande studio dal Signor MAFFEO PINELLI Veneziano, tomo quarto. Venezia, 1787.

This library was bought by a London dealer and was sold at auction in 1789-90 (1), this arithmetic going to a Mr. WODHULL for only three shillings (2). The book appeared about a hundred years later in the library of BRAYTON IVES, of New York, and when this was dispersed at auction Mr. GEORGE A. PLIMPTON added it to his already extensive collection of early textbooks.

Such a work, epoch-making as it was in the history of education, deserves the attention of all who are interested in the evoluiton of teaching. It is, however, so rare as to be inaccessible to most students, and is in the Venetian dialect of the period, and for this reason it has seemed a matter of duty to make a few portions of the text available for study.

Those who read with interest the story of science, who find lessons that are helpful in the early efforts of the schools, and who feel that we shall teach better in the future from knowing the experiments of the past, will find much that is worthy of reflection in this first attempt at a printed textbook in the ancient science of arithmetic. They will recognize at least a good intent in the midst of its crudities of language and number work, and will, if they have the opportunity and patience to read the entire work, pardon its wearisome repetitions because of the efforts of the author to make his subject clear and helpful to the youth of Treviso.

The unknown writer styles his work a 'Practica', a name quite common in speaking of commercial arithmetic in the Renaissance period in Italy. The German expression, 'Welsch Praktik', meaning Italian practice, or Italian methods in arithmetic, has its origin in such titles. The author also speaks of it as 'larte de labbacho' (for 'l'arte del abaccho'), the art of the abacus, in spite of the fact

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(1) BRUNET, J.-C., *Manuel du libraire et de l'amateur de livres*, 5e édition, Paris, 1862. The sale catalogue has this entry : « 1132 Arte dell' Abbaco, Treviso, senza nome di stampatore, MCCCCLXXXVIII (error for MCCCCLXXVIII), 4to ». The sale number, 1132, still appears on the cover of the PLIMPTON copy, with an inscription showing that it belonged to the PINELLI collection.

(2) It appears by a note on the fly leaf that he bought it on February 6, 1790, for three shillings. This price also appears in the catalogues of the sale now in the British Museum, the Bodleian library, and the Bibliothèque Nationale. In the *Genteleman's Magazine*, vol. 59, it appears that the sale began on April 6, 1789, but that « the whole of the Italian, French, and English books... will form a sale of thirty-two days continuance, and will commence on Monday the 1st of February, 1790 ».

that the abacus had been entirely forgotten in Italy some generations before the Treviso arithmetic appeared, although not in the countries of the North. He also speaks of 'arismetrica', a form that was common at this period, owing to a confused idea that the word 'arithmetic' contained the root 'metrica'.

Translation of Typical Portions.

Here beginneth (1) a Practica, very helpful to all who have to do with that commercial art commonly known as the abacus.

I have often been asked by certain youths in whom I have much interest (2), and who look forward to mercantile pursuits, to put into writing the fundamental principles of arithmetic, commonly called the abacus. Therefore, being impelled by my affection for them, and by the value of the subject, I have to the best of my small ability undertaken to satisfy them in some slight degree, to the end that their laudable desires may bear useful fruit. Therefore in the name of God I take for my subject this work in algorism (3), and proceed as follows :

All things which have existed since the beginning of time have owed their origin to number (4). Furthermore, such as now exist are subject to its laws, and therefore in all domains of knowledge this Practica is necessary. To enter into the subject, the reader must first know the basis of our science. Number is a multitude brought together or assembled from several units, and always from two at least (5), as in the case of 2, which is the first and the

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(1) Fol. i r begins with this word, — « Incommincia. »

(2) The author seems, therefore, to have been a teacher of commercial arithmetic in Treviso.

(3) The Hindu-Arabic arithmetic was commonly called « algorism » in the later Middle Ages. The name came from that of MOHAMMED IBN MUSA AL-KHOWÂRIZMI. He was born in Khwarezm, near the present Khiva, about the beginning of the ninth century, and wrote a celebrated arithmetic.

(4) A quotation from BOETHIUS, c. 500 A. D.

(5) Number was generally looked upon as a collection of units until about 1600 A. D. Unity itself was not, therefore, considered a number. Thus the author of the geometry often attributed to BOETHIUS (c. 500 A. D.) says : « Primum autem numerum id est binarium, unitas enim... numerus non est, sed fons et origo numerorum »... VICTORIUS (457 A. D.), who wrote before BOETHIUS,

smallest number. Unity is that by virtue of which anything is said to be one. Furthermore be it known that there are three kinds of number, of which the first is called a simple number, the second an article, and the third a composite or mixed number. A simple number is one that contains no tens, and it is represented by a single figure, like i, 2, 3, etc. (1). An article is a number that is exactly divisible by ten, like i0, 20, 30, and similar numbers (2). A mixed number is one that exceeds ten but that cannot be divided by ten without a remainder, such as ii, i2, i3, etc. (3). Furthermore be it known that there are five fundamental operations (4) which must be understood in the Practica, viz., numeration, addition, subtraction, multiplication, and division. Of these we shall first treat of numeration, and then of the others in order.

Numeration is the representation of numbers by figures (5). This is done by means of ten letters or figures, as here shown. .i., .2., .3., .4., .5., .6., .7., .8., .9., .0.. Of these the first figure, i, is not called a number but the source of number. The tenth figure, 0, is called

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probably had the same idea, which indeed goes back to the Greeks, for he says: « Unitas illa, unde omnis numerorum multitudo procedit »... MOHAMMED IBN MUSA AL KHOWÂRIZMÎ, also held this view, for he says (ADELARD OF BATH'S version): « Quia unum est radix universi numeri, et est extra numerum. » STEVIN, at the close of the 16th century, was the first prominent writer to clearly assert that unity is a number.

(1) What the author here calls a simple number was usually called by the Latin writers a *digitus* whence our word *digit*. These were originally the numbers of the fingers (*digits*).

In general in this as in all arithmetics of the late Middle Ages and early Renaissance, the Hindu-Arabic numeral in a text was separated from the rest of the sentence by periods, this line appearing as . i. 2. 3. etc. In this translation these periods are usually omitted and the use of i for 1 has been maintained on the first few pages as a minor bit of interest. In this early stage of printing MANZOLO (MANZOLINO) did not have any type for 1, a peculiarity found in several of the first printed arithmetics.

(2) An article was called by the Latin writers *articulus* a joint, doubtless from the ancient finger symbolism.

(3) These were the *numeri compositi* of the mediæval writers, i. e., « Numbers composed » of digits and articles.

(4) Many writers gave others, including doubling, halving, roots, and progressions.

(5) The distinction between notation and numeration is relatively modern, a product of the superlative refinement of the later schools. RAMUS was one of the first to make the distinction.

cipher or « nulla », *i. e.* the figure of nothing, since by itself it has no value, although when joined with others it increases their value. Furthermore you should note that when you find a figure by itself its value cannot exceed nine, *i. e.*, 9; and from that figure on, if you wish to express a number you must use at least two figures, thus : ten is expressed by i0, eleven by ii, and so on.

[The author now takes up the writing of units, tens, and hundreds].

And this suffices for a statement concerning the 'act' (1) of numeration.

Having now considered the first operation, viz. numeration, let us proceed to the other four, which are addition, subtraction, multiplication, and division (2). To differentiate between these operations it is well to note that each has a characteristic word, as follows:

Addition has the word	*and*,
Subtraction has the word	*from*,
Multiplication has the word	*times*,
Division has the word	*in*.

It should also be noticed that in taking two numbers, since at least two are necessary in each operation, there may be determined by these numbers any one of the above named operations. Furthermore each operation gives rise to a different number, with the exception that 2 times 2 gives the same result as 2 and 2, since each is 4. Taking, then, 3 and 9 we have :

Addition :	3	and (3)	9	make	12
Subtraction :	3	from	9	leaves	6
Multiplication :	3	times	9	makes	27
Division :	3	in	9	gives	3

(1) The fundamental operations, which the author calls « acts » (atti) went by various names. The mediæval Latin writers called them « species », a word that appears in *The Crafte of Nombrynge*, the oldest English manuscript on arithmetic, where the author speaks of « 7 spices or partes of this craft ». This word, in one form or another, is also found in various languages. The Italians used both « atti » and « passioni ».

(2) This order was by no means universal. Writers often placed multiplication before subtraction and some (Elia Misrachi, *c.* 1455-1525, for example) considered multiplication as merely addition. Rabbi ben Ezra (*c.* 1140), Fibonacci (1202), and others followed this order : multiplication, division, addition, subtraction, fractions, proportion, and roots, but of course took for granted some ability in adding.

(3) It should be remembered that at this time there were practically no symbols of operation or equality. In general, these came into use between about 1550 and 1650.

We thus see how the different operations with their distinctive words lead to different results.

In order to understand the second operation, addition (1), it is necessary to know that this is the union of several numbers, at least of two, in a single one, to the end that we may know the sum arising from this increase. It is also to be understood that, in the operation of adding, two numbers at least are necessary, namely the number to which we add the other, which should be the larger, and the number (2) which is to be added, which should be the smaller (3). Thus we always add the smaller number to the larger, a more convenient plan than to follow the contrary order, although the latter is possible, the result being the same in either case. For example, if we add 2 to 8 the sum is 10, and the same result is obtained by adding 8 to 2. Therefore if we wish to add one number

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(1) The word has had many vicissitudes. JOHN OF LUNA (c. 1140) called the operation aggregation, saying: « Agregare est quoslibet duos numeros uel plures in unum colligere ». An early French algorism of c. 1275 says: « Se tu veus *assamble*, l. nombre a autre ». The word *summation* has often been used as a synonym, as in RUDOLFF's (1526) chapter entitled *Addirn oder Summirn*, and in STIFEL's (1545) and ALBERT's (1561 edition) works. *Additio oder Summierung* appears in GRAMMATEUS (1518). The Germans also used *Zusammenthung*, the French *ajouster*, and the Italians *recogliere*, *summarare*, and *acozzare*, for the noun or verb. ADAM RIESE (1550 edition) has a chapter entitled « Addirn, Summirn, Zusamen legen », the last suggesting the old counter reckoning. In the Treviso arithmetic the word *join* (*iongere*) is used for « add »

(2) It will be seen that this does not differ essentially from our plan. Some writers, MAXIMUS PLANUDES (14th century) for example, placed the sum at the top, and others added from left to right, changing the partial sums when the following results exceeded 10. Occasionally, as with GEMMA FRISIUS (1540), the partial sums were all written and then added.

(3) As was usually the case with the early printed commercial arithmetics, the addends had no distinctive name. This is evidenced in the works of writers like PACIOLO (1494), PELETIER (1549), RECORDE (c. 1542), TRENCHANT (1566), SFORTUNATI (1534), BAKER (1568), DIGGES (1572), PAGANI (1591), and most of the Dutch writers. Even our American arithmetic of 1729 does not use the word *addend*. The early theoretical arithmetics, however, being written in Latin, spoke of the *numeri addendi* (numbers to be added). FINAEUS as early as 1525, and GEMMA FRISIUS as early as 1540, used only *addendi*, and from this comes our word *addends*. Curiously enough, TONSTALL who wrote the first real arithmetic to be printed in England (1522) did not use the word, although he wrote in Latin. Sometimes the name *numerus addendus* is applied only to the lower of two numbers, as by GEORGE OF HUNGARY (1499).

to another we write the larger one above and the smaller one below, placing the figures in convenient order, *i. e.*, the units under units, tens under tens, hundreds under hundreds, etc. We always begin to add with the lowest order, which is of least value. Therefore if we wish to add 38 and 59 we write the numbers thus :

59
38
Sum (1) 97 (2)

We then say, '8 and 9 make 17', writing 7 in the column which was added, and carrying the 1 (for when there are two figures in one place we always write the one of the lower order and carry (3) the other to the next higher place). This 1 we now add to 3, making 4, and this to the 5, making 9, which is written in the column from which it is derived. The two together make 97.

The proof of this work consists in subtracting either addend from the sum, the remainder being the other. Since subtraction proves addition, and addition proves subtraction, I leave the method of proof until the latter topic is studied, when the proof of each operation by the other will be understood.

Besides this proof there is another. If you wish to check the

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(1) We are so accustomed to seeing the word *sum* used for the result of addition that we are surprised to see other words used for the result. Product has commonly been used, however, as its synonym, as in the writings of JEAN DE MEURS (*c.* 1320), SAVONNE (1563), and others. Some of the late Latin writers also used *numerus collectus*, which might have given us *collect* if fashion had not decreed the use of *sum*.

(2) The writing of the sum at the bottom has not been universal. MAXIMUS PLANUDES (14th century) wrote it at the top, as did many of the Arab writers by whose works he was influenced. The Hindus, however, seem generally to have written the sum below.

(3) The expression « to carry » comes from the days of the old computation with counters (jetons, Rechenpfennige, projectiles), when a piece was actually carried from one line to another on the mediæval abacus. *Portare* was a common Italian word for the process. The early arithmeticians in England commonly said « keepe in mynde », as in RECORDE (*c.* 1542) and BAKER (1568). HODDER (10th edition, 1672), a very successful writer, uses *carry* in all cases.

sum by casting out nines (1), add the units, paying no attention to 9 or 0, but always considering each as nothing. And whenever the sum exceeds 9, subtract 9, and consider the remainder as the sum. Then the number arising from the sum will equal the sum of the numbers arising from the addends. For example, suppose that you wish to prove the following sum :

.59.
.38.
Sum .97. | 7

The excess of nines in 59 is 5; 5 and 3 are 8; 8 and 8 are 16; subtract 9 and 7 remains. Write this after the sum, separated by a bar. The excess of nines in 97 is 7, and the excess of nines in 7 equals 7, since neither contains 9. In this way it is possible to prove the result of any addition of abstract numbers or of those having no reference to money, measure, or weight.

[The author now considers the addition of larger numbers and then devotes about eight pages to the addition of such numbers as involve lire, soldi, and pizoli.]

Having now considered the second operation of the Practica of arithmetic, namely the operation of addition, the reader should give attention to the third, namely the operation of subtraction (2).

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(1) I have used this expression instead of « proof of nines », and have used « excess of nines », instead of « proof of nine », as being more intelligible to English readers. This method of proof is very old, AVICENNA (978-1036) speaking of it as due to the Hindus (« Fī'l-tharīk al-hindaci », the method of the Hindus). From India it was introduced into the Arab schools, where it was very popular owing to the extensive erasure of figures on the dust-covered board used in computing.

(2) The word *subtract* is by no means universal. In fact it is a school word rather than one of the business world today. We commonly use *deduct* or *take* in its stead. It is from *sub* (under) and *trahere* (to draw), whence *tractum*. FIBONACCI (1202) used *extract*, and CARDAN (1539) used *detract*, which is better than either. We have also had *subduction*, as in RAMUS (1569) and SCHONERUS (1586), and both of these writers use *subducto* and *tollo* for « I subtract ». DIGGES (1572) says : « To subduce or subtray any sume is wittily to pull a lesse frō a bigger nūber ». JOHANNES HISPALENSIS (c. 1150) uses both *diminuere* and *subtrahere*. HYLLES (1600) uses *abate*, *subtract*, *deduct*, and *take away*, as synonyms.

The word *subtraction* itself had many vicissitudes. The Latin *sub* appears in French as *sou*, *subtrahere* as *soustraire*, and *subtraction* as *soustraction*, the *s*

Therefore I say that the operation of subtraction is nothing else than this : that of two numbers we are to find how much difference there is from the less to the greater, to the end that we may know this difference. For example, take 3 from 9 and there remains 6. It is necessary that there should be two numbers in subtraction, the number from which we subtract and the number which is subtracted from it (1).

The number from which the other is subtracted is written above, and the number which is subtracted below, in convenient order, viz., units under units and tens under tens, and so on. If we then wish to subtract one number of any order from another we shall find that the number from which we are to subtract is equal to it, or greater, or less. If it is equal, as in the case of 8 and 8, the remainder is 0, which 0 we write underneath in the proper column. If the number from which we subtract is greater, then take away the number of units in the smaller number, writing the remainder below, as in the case of 3 from 9, where the remainder is 6. If, however, the number is less, since we cannot take a greater number from a less one, take the complement (2) of the larger number

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having been inserted for euphony, as in « abstract » instead of « abtract ». Hence in some of the early Latin books printed in Paris the *s* crept into the word *subtractio* so that it appears in the incorrect form *substractio*. Thus the word appears in CLICHTOVEUS (1503), SACROBOSCO (edition of 1510), and GEORGE OF HUNGARY (1499), while COGNET (1573), under the French influence in Holland, used the same form, as did most of the early Dutch writers before 1800. A noteworthy exception to the last statement is seen in the words of ADRIEN METIUS (1633). From France and Holland *substract* found its way to England and was common until a century ago, as also in the American colonies. It still survives in the United States among illiterate people.

(1) The writer does not use the Latin terms « minuend » and « subtrahend », abbreviations of « numerus minuendus » and « numerus subtrahendus », but translates the full Latin phrases. Some writers called them the larger and smaller numbers. Thus TONSTALL (1522) speaks of the *numerus superior* and the *numerus inferior*, and the Italian edition of CLAVIUS (1586) calls them the *numero superiore* and *numero inferiore*. GEMMA FRISIUS (1540) calls the smaller number the subducend (*subducendus*). Among the other common names are « total and less » (*totalis et numerus minor*, as in TZWIVEL, 1505), « total and abatement » (as in HYLLES, 1592), « debt and payment » (as in WENTSEL, 1599 ; ORTEGA, 1512 ; TRENCHANT, 1566 ; SANTA-CRUZ, 1594) ; and « greater and less » (SFORTUNATI, 1534 ; TARTAGLIA, 1556 ; RAETS, 1580).

(2) I have had to employ some circumlocution here, since we do not have the exact phrase employed by the writer.

with respect to 10, and to this add the other, but with this condition : that you add one to the next left-hand figure. And be very careful that whenever you take a larger number from a smaller, using the complement, you remember the condition above mentioned. Take now an example : Subtract 348 from 452, arranging the work thus :

	452
	348
Remainder (1)	104

First we have to take a greater number from a less, and then an equal from an equal, and third, a less from a greater. We proceed as follows (2) : We cannot take 8 from 2, but 2 is the complement of 8 with respect to 10, and this we add to the other 2 which is above the 8, thus : 2 and 2 make 4, which we write beneath the 8 for the remainder. There is, however, this condition, that to the figure following the 8 (viz., to 4), we add 1, making it 5. Then 5 from 5, which is an equal, leaves 0, which 0 we write beneath. Then 3 from 4, which is a less from a greater, is 1, which 1 we write under the 3, so that the remainder is 104.

If we wish to prove this result, add the number subtracted to the remainder, and the result will be the number from which we subtracted. We may arrange the work as follows :

452	2
348	6
104	5
452	

(1) The term is *Lo resto*, the rest. We still use this when we say, "Take what you wish and leave me the *rest*", or "The rest have gone". It was and still is a common synonym for remainder, particularly in Italy, Spain, and France. The Latin writers (like FINAEUS, 1525) often used *numerus residuus*, and occasionally like CLAVIUS (1583), *differentia sive excessus*, or (GLARANUS, 1538), *relictum* and *reliquum*.

(2) The complementary subtraction given on the preceding page and here is one of the six common methods of performing the operation in question. It is often found in mediæval works and depends upon the principle that $a - b = a + (10 - b) - 10$. It is familiar to all who have used cologarithms.

Now add, 4 and 8 are 12; write 2 under the 4 and carry 1; then 1 and 4 are 5; write this 5 under the 0; then add 1 and 3, making 4, and write this 4 under the 1, and the work checks. Thus is found that which was promised you, as you can see.

[The author now gives a further proof of subtraction by the casting out of nines, after which he devotes about six or seven pages to checks on subtraction and to the subtraction of lire, soldi, grossi, pizoli, and the like.]

Having now explained the third operation, namely that of subtraction, the reader should give attention to the fourth, namely that of multiplication. To understand this it is necessary to know that to multiply one number by itself or by another is to find from two given numbers a third number which contains one of these numbers as many times as there are units in the other. For example, 2 times 4 are 8, and 8 contains 4 as many times as there are units in 2, so that 8 contains 4 in itself twice. Also the 8 contains 2 as many times as there are units in 4, and 4 has in itself four units, so that 8 contains 2 four times. It should be well understood that in multiplication two numbers are necessary, namely the multiplying number and the number multiplied, and also that the multiplying number may itself be the number multiplied, and vice versa, the result being the same in both cases. Nevertheless usage and practice demand that the smaller number shall be taken as the multiplying number, and not the larger. Thus we should say, 2 times 4 makes 8, and not 4 times 2 makes 8, although the results are the same. Now not to speak at too great length I say in brief, but sufficiently for the purposes of a Practica, that there are three methods of multiplication, viz., by the tables, cross multiplication, and the chess-board plan. These three methods I will explain to you as briefly as I am able. But before I give you a rule or any method, it is necessary that you commit to memory the following statements, without which no one can understand all of this operation of multiplication.

[The author now gives the multiplication table, omitting all duplications like 3×2 after 2×3 has been given, but extending for « those who are of scholarly tastes » the table to include multiples of 12, 20, 24, 32 and 36, as needed in the monetary systems used by merchants of the time.]

I have now given you to learn by heart all the statements needed in the Practica of arithmetic, without which no one is able to master the Art. We should not complain, however, at having to learn

these things by heart in order to acquire readiness; for I assure you that these things which I have set forth are necessary to any one who would be proficient in this art, and no one can get along with less. Those facts which are to be learned besides these are valuable, but they are not necessary.

Having learned by heart all of the above facts, the pupil may with zeal begin to multiply by the table (1). This operation arises when the multiplier is a simple number, and the number multiplied has at least two figures, but as many more as we wish. And that we may more easily understand this operation we shall call the first figure toward the right, units; the second toward the left, tens, and the third shall be called hundreds. This being understood, attend to the rule of working by the table, which is as follows (2): First multiply together the units of the multiplier and the number multiplied. If from this multiplication you get a simple number, write it under its proper place; if an article, write a 0 and reserve the tens to add to the product of the tens; but if a mixed number (3) is found, write its units in the proper place, and save the tens to add to the product of the tens, proceeding in the same way with all the other orders. Then multiply together the units of the multiplier with the tens; then with the hundreds, and so on in regular order.

[The author now gives an example in multiplying by a one-figure number, proving the work by casting out nines. He then gives a proof by casting out sevens, after which he sets forth various methods of multiplication, such as that of the chessboard, that of the quadrilateral, or the one known by the name of gelosia, all of which were in common use at the time.]

In order to understand the fourth operation, viz., division, three things are to be observed, viz., what is meant by division; second, how many numbers are necessary in division; third, which of these numbers is the greater. As to the first I say that division is the

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(1) "Moltiplicare per colona", that is, by the columns of the table.

(2) The early rules were merely general directions. The idea of condensing these directions into the briefest possible statement, oftentimes obscuring the process thereby, did not manifest itself before the XVIIth century, and did not culminate until the XIXth. The natural reaction against this extreme form of statement has of late led to abolishing rules entirely, although this is also an extreme that is undesirable.

(3) That is, a *numerus compositus*.

operation of finding, from two given numbers, a third number, which is contained as many times in the greater number as unity is contained in the less number. You will find this number when you see how many times the less number is contained in the greater. Suppose, for example, that we have to divide 8 by 2; here 2 is contained 4 times in 8, so we say that 4 is the quotient demanded. Also, divide 8 by 4. Here the 4 is contained 2 times in 8, so that 2 is the quotient demanded.

Second, it is to be noticed that three numbers are necessary in division, — the number to be divided, the divisor, and the quotient, as you have understood from the example above given, where 2 is the divisor, 8 the number to be divided, and 4 the quotient. From this is derived the knowledge of the third thing which is to be noted, that the number which is to be divided is always greater than, or at least is equal to, the divisor. When the numbers are equal the quotient is always 1.

Now to speak briefly, it is sufficient in practice to say that there are two ways of dividing, — by the table and the galley method. In this operation you should begin with the figure of highest value, that in by the one which is found at the left, proceeding thence to the right. If you can divide by the table you will be able to divide by the galley method, and it is well, for brevity, to avoid the latter when you can. Therefore this is the method of dividing by the table: See how many times your divisor is found in the first left-hand figure, if it is contained in it, and write the quotient beneath it. If it is not so contained, consider this figure as tens and take together with it the following figure; then, finding the quotient write it beneath the smaller of the two figures. If there is any remainder, consider this as tens, and add it to the next number to the right, and see how many times your divisor is found in these two figures, writing the quotient under the units. In this same way proceed with the rest of the figures to the right. And when you have exhausted them all, having set down the quotient, write the remainder at the right, separated by a bar; and if the remainder is 0, place it where I have said. In the name of God I propose the first example, so attend well.

[The author now devotes twelve quarto pages to completing the explanation of division, a fact which shows the difficulty which the subject was thought to possess. He then proceeds to take up the famous Rule of Three, one of several methods of treating an

equation — or problems which we now solve by equations — before the advent of a satisfactory symbolism.]

The operations which I have set forth above being understood, it is necessary to take up the method and the rules of using them. The rule you must now study is the rule of the three things. Therefore that you may have occasion to sharpen your understanding in the four operations above mentioned, — addition, subtraction, multiplication, and division, — I shall compare them. As a carpenter (wishing to do well in his profession) needs to have his tools very sharp, and to know what tools to use first, and what next to use, &c., to the end that he may have honor from his work, so it is in the work of this Practica. Before you take the rule of the three things it is necessary that you should be very skilled in the operations which have been set forth in addition, subtraction, multiplication, and division, so that you may enter enthusiastically into your work. Furthermore, that the rule of the three things, which is of utmost importance in this art, may be at your command, you must have at hand this tool of the operations, so that you can begin your labors without spoiling your instruments and without failing. Thus will your labors command high praise.

The rule of the three things is this : that you should multiply the thing which you wish to know, by that which is not like it, and divide by the other. And the quotient which arises will be of the nature of the thing which has no term like it. And the divisor will always be dissimilar (in weight,in measure, or in other difference) to the thing which we wish to know.

In setting forth this rule, note first that in every case which comes under it there are only two things of different nature, of which one is named twice, — by two different numbers, — and the other thing is named once, by one number alone. For example :

If 1 lira of saffron is worth 7 lire of pizoli, what will 25 lire of this same saffron be worth ? Here are not mentioned together both saffron and money, but the saffron is mentioned twice by two different numbers, 1 and 25; and the money is mentioned once, by the one number 7. So this is not called the rule of three things because there are three things of different nature, for one thing is mentioned twice.

Secondly, be it noted that in order to learn to know the three things by their three several names, — which are : the thing which has none similar to it, the thing which you wish to know, and the

divisor, — know that that thing which is mentioned once is the one that is called the thing which has none similar to it, and which is most easily distinguished. And in order that you may be able to recognize the divisor of the thing which you wish to know, note that that thing is always the divisor that manifestly changes or transforms itself into the other thing. Having recognized the names of the two preceding things, the third thing is that which you wish to find. Therefore, in this example, 1 is the divisor, 7 the thing which has none similar to it, and 25 is the thing which you wish to know.

Thirdly it is to be noted, that in this particular, as the rule says, the divisor should always be dissimilar to the thing which you wish to know, and indeed it is always so by nature when the two are of one substance, as if I should say in respect to weight or of measure. For even if they be named by various weights, or diverse measures, any two may be reduced to the denomination of the lesser weight or measure. For example, suppose that you asked: « If 1 lira of saffron is worth 7 lire of pizoli, what will be the value of 1 ounce? » I say that the divisor, which now is 1 lira, may be reduced to the nature of ounces, saying: « 1 time 12 is 12 ». Then we may say: « If 12 ounces of saffron are worth 7 lire, what will be the value of 1 ounce? » Thus we have arranged it so that two things harmonize in weight, which at first were dissimilar. This being accomplished, we may begin the solution.

[The author now devotes twenty-four pages to an elaborate explanation of the Rule of Three, the most important single commercial rule then in common use. He then proceeds with the following statement :]

Notwithstanding the things already set forth, I wish now (to satisfy the more completely your longing and endeavor) to teach you five other styles of problem, and to these I invite your attention.

And first I wish to show you certain problems in the rule of three things, in which (notwithstanding the aforesaid rule of three things) if you divide the product of the multiplication of the other terms by the term which is interchanged with the one which has none similar to it, the resulting quotient will be of the same nature as the term which you seek.

Secondly : I shall teach you to discount tare and tret.

Third : Problems in partnership.

Fourth : Problems in barter.

Fifth : Problems in alloys of coins.

And concerning each of these topics I shall show you only three problems.

As to the three problems under the first topic :

When a bushel of wheat is worth 8 lire (1), the bakers make a loaf of bread weighing 6 ounces ; required the number of ounces in the weight of a loaf when it is worth 5 lire a bushel (2).

I have 16 florins worth 4 lire and 12 soldi and ½ each, which I wish to change into ducats worth 5 lire, and 14 soldi and 1/3 each. How many shall I have ?

I have 9 yards and 2/3 of cloth 2 yards and 3/4 wide, which I wish to make into a garment. I wish to line this with cloth 1 yard and 1/8 wide; how much do I need ?

[The author now gives the solutions by the Rule of Three.]

As to the three problems of the second topic, tare and tret (3).

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(1) This must have meant famine prices, since the lira was 10 ducats, or about $ 14 as exchange ran in TARTAGLIA's time.

(2) This is one of the standard problems in the history of mathematics, and it tells part of an interesting custom. Loaves were formerly of two kinds : (1) " assized bread ", always sold at the same price, and varying in weight according to the price of wheat, as in this problem; (2) " prized bread ", always of the same weight but varying in price. (The question is discussed in J. NASMITH's *An examination of statutes . the assize of bread*, Wisbeck, 1800.) Legal regulations of the weight of loaves are found in the Frankfort capitulary of 794 A. D , and very likely in the Roman law. London regulations are found as early as the XII^th^ century, and in the " assize of bread " of HENRY II they are worked out by inverse proportion as in the Treviso arithmetic. Part of these regulations is as follows : " Quando quartierum frumenti se vendit pro sex sol. ; tunc debet panis esse bonus et albus et ponderare sexdicim sol. XX^ti^ lores (*i. e.* 20 pence to an ounce)... Quando pro quatuor sex sol. et alius quadraginta sex sol . . ", and so on for different weights. (W. CUNNINGHAM, *The Growth of English Industry and Commerce during the Early and Middle Ages*, p. 568, London, 1896.) As a result, tables of the assize of bread were prepared, and their use was made obligatory. Such a table, from the Record Book of the city of Hull, is reproduced in facsimile in E. P. CHENEY's *An Introduction to the Industrial and Social History of England*, p. 67, New York, 1901, and in LAMBERT's *Two thousand years of Gild Life*. There is also a rare tract, containing sixteen pages of tables by JOHN POWELL, entitled *Assize of Bread*, published in London in 1615.

(3) Until a generation or so ago the chapter on tare and tret was one of the most prominent in applied arithmetic. Thus we find the « Regula de tre de tara » (ORTEGA, 1512), « Righel van Tara » (STOCKMANS, 1589), « Delle tare a

If a hundredweight of yarn is worth 8 (1) ducats, what is the value of the tare, at 4 pounds per hundred (2), on 4562 pounds?

If a hundredweight of cotton is worth 36 ducats, 10 grossi, 10 pizoli, what is the amount to be deducted for 8348 pounds, tare being 6 pounds per hundred, and tret 2 ducats per hundred weight ?

If a hundredweight of wool is worth 19 ducats, 14 grossi and 1/2, what should be deducted for 9968 (3) pounds, tare being 3 per cent, and tret 2 and 3/4 ?

[Now follows the solutions.]

Now as to the third class of problems, partnership :

Three merchants have invested their money in a partnership, whom to make the problem clearer I will mention by name. The first was called Piero, the second Polo, and the third Zuanne. Piero put in 112 ducats, Polo 200 ducats, and Zuanne 142 ducats. At the end of a certain period they found that they had gained 563

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yn tanto per cento » (Ciacchi, 1675), « Thara-Rechnung » (Starcken, 1714 edition), and so on. In Baker's *Well spring of Sciences* (1568) « The eyght chapter treateth of Tares and allowances of Marchandise solde by weight » (1585 edition, fol. 135). The following from the Mellis edition of Recorde's *Ground of Artes* (1594 edition, p. 487) may illustrate the early English problems : « Item at 3 s̃ 4 d the pound weight, what shal 254 l/2 be worth, in giuing 4 l weight upon euery 100 for treate ? » « Item if 100 l be worth 36 s̃ 8 d, what shal 800 l be worth in rebating 4 pound upon euery 100 for tare and cloffe ? »

The word tare is a silent witness to the Moslem influence in commercial affairs, coming from *tarha*, that which is thrown away. It refers to the allowance made for the weight of a box or cask in which merchandise is sold. *Tret* is from the Italian *tratto*, allowance for transportation (*trattare*, to carry), 4 lb. being usually added to every 100 lb. of net weight after the tare was deducted. *Cloff* was an allowance of 2 lb. formerly made on every 3 cwt of certain goods, that the weight might hold out in retailing.

(1) Should be 18 as, in the solution.

(2) That is, in the Italian, *per cento*, or per cent. There is no objection to saying « 4 pounds per cent, » meaning 4 pounds per hundred pounds. Indeed, in England it is a common expression, although in the United States we do not use a denominate number before per cent. We commonly say that per cent is from the Latin *per centum* (per hundred), and so it is in a way ; but the expression came into English from the Italian merchants who came, in the fifteenth century, to make much use of *per cento*. They finally abbreviated this into p c, and then dropped the p (for *per*). From c° came our symbol %, by a very natural evolution, as shown by facsimiles in my *Rara Arithmetica*, p. 440.

(3) Should be 4562 as in the solution.

ducats. Required to know how much falls to each man so that no one shall be cheated.

Two merchants, Sebastiano and Jacomo, have invested their money for gain in a partnership. Sebastiano put in 350 ducats on the first day of January 1472, and Jacomo 500 ducats, 14 grossi on the first day of July 1472. And on the first day of January 1474 they found that they had gained 622 ducats. Required the share of each.

Three men, Tomasso, Domenego, and Nicolo, entered into partnership, Tomasso put in 760 ducats on the first day of January, 1472, and on the first day of April took out 200 ducats. Domenego put in 616 ducats on the first day of February, 1472, and on the first day of June took out 96 ducats. Nicolo put in 892 ducats on the first day of February, 1472, and on the first day of March took out 252 ducats. And on the first day of January 1475 they found that they had gained 3168 ducats, 13 grossi and ½. Required the share of each, so that no one shall be cheated.

[The solutions of these problems, the subject then being a matter of great importance in the commercial world, is given by the Rule of Three.]

The fifth (1) kind of problem, concerns barter.

For example: Two merchants wish to barter. The one has cloth at 5 lire a yard, and the other has wool at 18 lire a hundredweight. How much cloth should the first have for 464 hundredweights of wool.

[Then follows the solution.]

There are two merchants of whom the one has cloth worth 22 soldi a yard, but who holds it in barter at 27 soldi. The other has wool which is worth in the country 19 lire per hundredweight. Required to know how much he must ask per hundredweight in barter so that he may not be cheated.

[The solution follows.]

There are two merchants who wish to barter. One has 1 peso of balsam worth 150 ducats. He wishes to trade this for three kinds of merchandise, viz., for wax at 5 ducats per hundredweight, sugar at 6 ducats per hundredweight, and ginger at 8 ducats per hundredweight. He wishes the same amount of one substance as

(1) Error for fourth.

the rest of the three kinds of merchandise. Required how much he will have of each.

[The solution follows.]

The fifth kind of problem promised above concerns the alloys of coins.

A merchant has 46 marks, 7 ounces, of silver, alloyed at 7 ounces and 1/4 per mark (1). He wishes to coin this so that it shall contain 3 ounces and 1/2 of fine silver per mark. Required to know the amount in the mixture and how much brass he must add.

[The solution follows.]

A merchant has 40 marks of silver containing 6 ounces and 1/2 of fineness per mark. He has 56 marks of another kind containing 5 ounces of fineness per mark. He wishes to make these into coin containing 4 ounces and 1/2 of fine silver per mark. Required to know that amount in the mixture, and the amount of brass to be added. In this problem you should first consider how much silver is found in the two given quantities, and first in the 40 marks, thus: If 1 mark yields 6 ounces and 1/2 of silver, what will 40 marks yield?

[The solution and another example follows.]

The student has now completed the five kinds of problem finally promised by me. It remains for me to add certain accomplishments, and at the same time certain features which will be useful to him.

The rule of the two things which come together is this: That you should multiply the two terms by one another and divide the product of this multiplication by the sum of the two numbers given.

The Holy Father sent a courier from Rome to Venice, commanding him that he should reach Venice in 7 days. And the most illustrious Signoria of Venice also sent another courier to Rome, who should reach Rome in 9 days. And from Rome to Venice is 250 miles. It happened that by order of these lords the couriers started on their journeys at the same time. It is required to find in how many days they will meet.

[The rest of the translation will include a few examples, the solutions being omitted.]

A hare is 150 paces ahead of a hound, which pursues him. The hare covers 6 paces while the hound covers 10. Required to know how many paces the hound has made when he overtakes the hare.

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(1) *I. e.*, 7 1/4 oz. of fine silver per mark.

A man has found a purse containing some ducats, I do not say how many. Of these he spends 1/4, 1/5, 1/6, and 9 ducats remain. Required the number of ducats in the purse when he found it.

I have found a purse with ducats, I do not tell you how many. I have spent 1/3 and 1/4 of them, and I now have 120 ducats in the purse. Required the number of ducats in the purse when I found it.

A carpenter has undertaken to build a house in 20 days. He takes on another man and says : 'If we build the house together, we can accomplish the work in 8 days. Required to know how long it would take this other man to build it alone.

If 17 men build 2 houses in 19 days, how many days will it take 20 men to build 5 houses ?

If 3 men eat three loaves in 4 days, required to know in how many days 10 men will eat 12 loaves ? This problem is solved (if you consider it well) like the preceding one.

The rule for finding the golden number is this : Divide by 19 the years of the Nativity of our Lord JESUS CHRIST which end in the year in which you seek the golden number. And paying no attention to the quotient, take the remainder and add 1 to it, and this is the golden number of the year sought.

[The book closes with a list of rules, chiefly for reducing from one measure to another, and with the following colophon.]

This is the register of the quartos of the present work.

[Then follows the initial words of the successive folios of each quarto, the first beginning 'Incommincia', the second 'tia. de la', etc. They are grouped in fours, this being a quarto book. There are no words for folios 5-8, these being parts of the first four sheets. Folio 9 begins with 'che. 2. e di', and so on.]

What availeth virtue to him who does not labor ? Nothing.

At Treviso, on the 10th day of December, 1478.

(*New York City*).

DAVID EUGENE SMITH.

Sonnenuhren der spätarabischen Astronomie

Vor einiger Zeit habe ich das Buch : « Die Gnomonik der Araber » veröffentlicht (Berlin, 1923), in deren Vorwort ich beklagte, keine lückenlose Darstellung von der Entwickelung der arabischen Sonnenuhrkunde geben zu können, weil mir gnomonische Manuscripte der spätarabischen Periode zu studieren damals nicht möglich war. Aber ich hoffte auf günstigere Gelegenheiten, und sie haben sich mir wider Erwarten schnell geboten : Seit Neujahr 1923 weilt Herr Dr. M. Meyerhof wieder als Augenarzt in Kairo. Er war bald in der Lage, mir eine Abschrift der Abhandlung des Muḥ ibn Abî'l Fatḥ Schams ad-dîn aṣ-Ṣûfî al-Miṣrî († Kairo 1494-1495) « *Ueber die ebene Sonnenuhr, genannt die Ruchâma* (Marmorplatte), aus der dortigen vicekönig-lichen Bibliothek erwerben zu können, und von einer zweiten, sehr bedeutenden und umfangreichen gnomonischen Schrift, nämlich der des Muḥ ibn Muḥ ibn Aḥmed Abû 'Abdallâh, Badr ad-dîn al-Miṣrî ad-Dimischqî, bekannt als Sibṭ al-Mâridînî (* 1423 in Damaskus, † 1494-95 in Kairo) : « Ueber die Berechnung von Tafeln zur Konstruktion der Munḥarifât », (geneigten Sonnenuhren) hat Herr Dr. George Sarton die Photos aus der *Bodleian Library* (Oxford) für mich erhalten, so dass es mir dadurch ermöglicht ward, einen Einblick in den Stand der Gnomonik dicht vor dem Niedergang der arabischen Wissenschaft zu tun und sonach festzustellen, ob die Sonnenuhrkunde der Araber bis dahin eine fortschrittliche Entwickelung gegenüber der früheren Zeit genommen habe oder nicht. Ich schulde den beiden Herrn für ihre hochherzigen materiellen Opfer, die sie damit der weiteren Erschliessung der noch so lückenhaft bekannten muslimischen Astronomie gebracht, und der Freude, die sie mir dadurch gemacht haben, meinen herzlichsten Dank, und indem ich demselben Ausdruck gebe, möchte ich auch dankbar der Bemühungen des Direktors der Bodleyana, Herrn Dr A. Cowley's, gedenken.

Bevor ich die Uebersetzung der beiden arabischen Manuscripte mitteile, möchte ich den Leser kurz über deren Inhalt orientieren, so dass ihm das Verständnis des Textes keine Schwierigkeiten mehr bieten dürfte.

Den beiden Schriften entnimmt man, *dass die Spätaraber sich ausschliesslich der* GLEICHEN *Stunden bedienten*, ein erfreulicher Fortschritt gegenüber der früh- und mittelarabischen Zeit, dann aber, dass SIBṬ AL-MÂRIDÎNÎ *tatsächlich den zum Weltpol gerichteten Sonnenzeiger, den sog.* POLOS, *inauguriert, womit bewiesen ist, dass diese als abendländisch bezeichnete Sonnenuhr, ihren Ursprung nicht ausschliesslich im Occident haben dürfte.* Ueber diese für die Geschichte der Gnomonik ausserordentlich wichtige und bis heute noch ungeklärte Frage möchte ich hier noch eine nähere Bemerkung machen.

In meiner oben genannten Schrift habe ich (Seite 90-91) vergebens nach dem « Urheber dieser glücklichen Neuerung » gefragt und die Richtigkeit der Vermutung R. WOLF's, dass der Polos doch in der arabischen Astronomie wurzeln dürfte, bezweifelt, mich dagegen der Ansicht J. B. DELAMBRE's zugeneigt, dass an dieser Stelle in der Geschichte der Gnomonik eine Lücke klaffe. Denn ganz plötzlich ist der Polos bei den ersten europäischen Gnomonisten (SEBASTIAN MÜNSTER, 1489-1552, JOH. SCHONER, 1477-1547) da, ohne dass sie sich als Erfinder desselben ausgeben. Es sind jetzt drei verschiedene Hypothesen möglich :

1. Entweder hatten die Araber schon *vor* SIBṬ AL-MÂRIDÎNÎ den Polos gekannt, er ist also nicht der Urheber und der Polos kam zu irgend einer Zeit von den Arabern zu den Europäern, oder aber

2. SIBṬ AL-MÂRIDÎNÎ ist der Erfinder — AṢ-ṢÛFÎ scheint den Polos ja nicht zu kennen — *nur für den Orient*, und das Abendland erfand ihn, unabhängig vom Morgenlande, ganz selbständig, endlich wäre

3. denkar, dass der Polos ein Arrangement rein abendländischer Herkunft ist und in spätarabischer Zeit zur Kenntnis des Morgenlandes kam. Diese letztere Hypothese ist die am wenigsten wahrscheinliche. Aus der hier zugänglich gemachten Schrift des SIBṬ AL-MÂRIDÎNÎ geht jedenfalls die eine wichtige Erkenntnis hervor, *dass ein spätarabischer Astronom* — bis heute war ja noch kein einziger Polos bei den Arabern nachzuweisen — *die sog. abendländische Sonnenuhr mit all ihren « verschiedenen Neuheiten » kannte.* Vielleicht bringt die Analyse anderer, noch nicht durchforschter orientalischen Handschriften die vollständige, so dringend erwünschte Klärung dieser Frage.

I

Es folgen jetzt die nötigen Prämissen zum Verständnis der Ausführungen von AṢ-ṢÛFÎ. Zuerst konstruiert der Autor eine *Horizontalsonnenuhr*, (*al-Basiṭa* = die ebene, die ausgebreitete) die, weil sie meist auf einer Marmorplatte ausgeführt wurde, auch *ar-Ruchâma* (der Marmor) hiess. Fig. 1 stellt der Lineatur des Zifferblattes einer

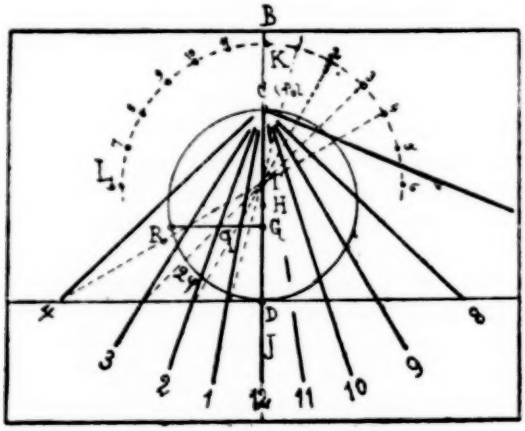

Fig. 1.

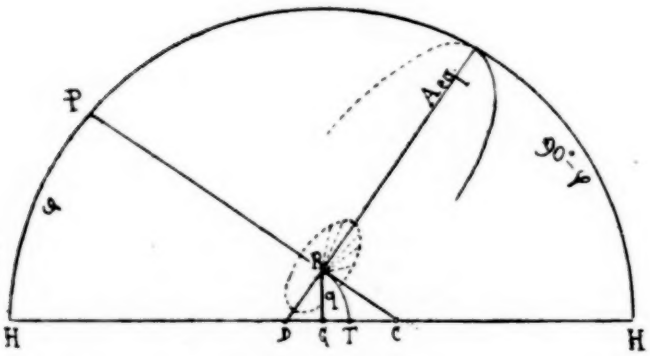

Fig. 2.

solchen Sonnenuhr vor, die unter Beachtung der Fig. 2 leicht verständlich ist.

a) Es ist nämlich :

$$GC = q.\ \text{cotg}\ \varphi$$
$$GD = q.\ \text{tang}\ \varphi$$

$$DC = q.\ (\text{tang}\ \varphi + \text{cotg}\ \varphi) = q.\left(\frac{\sin\varphi}{\cos\varphi} + \frac{\cos\varphi}{\sin\varphi}\right) = \frac{q}{\sin\varphi.\cos\varphi}$$

Ferner : $$\frac{DC}{2} = \frac{q}{\sin 2\varphi} = HD,$$

und auch : $$\frac{GR}{HR} = \frac{GR}{HD} = \sin 2\varphi = \frac{GR}{\frac{q}{\sin 2\varphi}},$$

d. h. $$GR = q,$$

wobei q die Länge des Gnomons, φ die geographische Breite ist.

Sodann ist :

$$DR\sqrt{q^2 + q.^2\,\text{tang}^2\,\varphi} = \frac{q}{\cos\varphi}.$$

Es liegt also DR in der Aequatorebene, in der die Stundenlinien lauter gleiche Winkel von 15° mit einander bilden. Diese Ebene ist, wie es Fig. 2 andeutet, auf den Horizont HH_1 niedergelegt ($DT = DR$); womit die Ermittlung der Stundenlinien der Fig. 1 nach dem bekannten, heute noch geübten Verfahren, erfolgt.

b) Nach demselben Prinzip gibt AṢ-ṢÛFÎ die Konstruktion der Stundenlinien einer um den Winkel α (Inḥirâf) von der Nordsüdrichtung abweichenden *Vertikalsonnenuhr* (Munḥarif, plur. : Munḥarifât). Den näheren Sachverhalt bringt Fig. 3 zur Anschauung. Die Uhr ist in der Vertikalebene AZFB enthalten, die den Horizont in der Spur AB (Horizontale) durchschneidet, während die Durchdringung der Uhrebene mit der Ebene des Himmelsäquators durch die Gerade EHF angedeutet ist. Der schattenwerfende Gnomon befindet sich in der Horizontalebene, die senkrecht auf AB steht. Er ist durch die kräftige Linie CR markiert. In unserem Fall ist $CR = q$ um das kleine Stück HC aus dem Weltmittelpunkt herausgerückt, was gegenüber dem Radius der Himmelskugel belanglos ist. Falls die Sonne im Himmelsäquator läuft, fallen alle Schatten der Stabspitze R in die Gerade YUY_1, die parallel EHF ist. Sie durchsetzt die Horizontale AB im Punkte U, dem Horizont des Aequators. Der horizontale Kreis

durch H und U ist der Kreis des Inḥirâf; denn da arc UR, nach Vorschrift, gleich dem doppelten Inḥiraf 2α ist, so wird $\sphericalangle$ UHR $= \alpha$, und HC $= q \cdot \operatorname{cotg} \alpha$. Die Spitze R des Gnomons berührt die Mittagslinie (Nord-Süd). Ist S der Pol, so ist die Verbindungslinie RS (die AṢ-ṢÛFÎ aber nicht zieht) um den Winkel der Polhöhe φ zur Mittagslinie geneigt, und RS ist der Polos. Dreht man jetzt das rechtwinklige Dreieck RHS um HS als Achse in die Lage THS, so ist notwendig $\sphericalangle$ HTS $= \sphericalangle \varphi$, und eine Senkrechte zum Winkelschenkel TS, nämlich TN, die unter dem Winkel $90° - \varphi$ zu AB zieht, muss YY_1 auf der

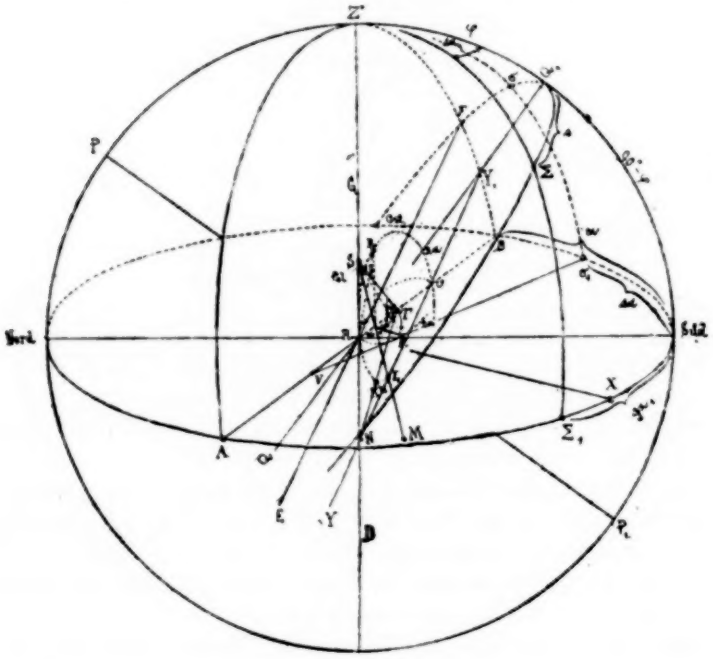

Fig. 3.

Verlängerung von SH, in einem Punkte N, treffen. Die Strecke HN ist der Zawâl (1) des Widders, d. h. N ist der Schattenpunkt von Q_1 hinsichtlich der Stabspitze R. Ferner ist : $HR = HT = \frac{q}{\sin \alpha}$, woraus

(1) Zawâl = Abstieg, in diesem Fall : Absteigen der Sonne von $Q_{1\,\mathfrak{V}}$ dem Kulminationspunkt des Himmelsäquators.

für die Länge der Schattens des Zawâls im Widder folgt :

$$HN = HR.\ \text{cotg}\ \varphi$$
$$= q.\ \frac{\text{cotg}\ \varphi}{\sin \alpha}$$

Ganz ähnlich hat man im rechtwinkligen Dreieck SHT für den Schatten des Pols :

$$HS = HT.\ \text{tang}\ \varphi$$
$$= q.\ \frac{\text{tang}\ \varphi}{\sin \alpha}$$ (Hypotenuse od. Durchmesser d. Inḥirâf)

Das Lot von S auf UN gibt die Mittagslinie der Uhr. Der Radius des Stundenkreises um M, nämlich LM, muss gleich der Hypotenuse des rechtwinkligen Dreiecks RCL sein (1). Nunmehr ist die Aequatorebene mit dem Stundenkreise um die sog. Kollineationsachse $NLUY_1$ in die Ebene der Wand AZFB umgelegt, daher der Fall *a*) jetzt gültig. Die Stundenlinien des Munḥarif laufen von YY_1 nach S.

Abhandlung des Scheichs Muh ibn Abi'l Fatḥ aṣ-Ṣûfi.

Einführung in die Konstruktion der Basîṭa, genannt die Ruchâma, auf geometrischem Wege.

Im Namen Allâhs, des barmherzigen Erbarmers! Mache es leicht, o Herr, mit deiner Gnade! Lob sei Allâh, dem Herrn der Welten, und Segen und Frieden auf Muḥammed und seine Familie, sowie die Genossenschaft aller Gläubigen! Und dies ist die Einführung in die Herstellung der Basiṭa, genannt die Ruchâma, auf geometrische Weise, die ihre Ausführung in der Moschee und Akademie (Madrasa) leicht ermöglicht. Sie erfordert keine Rechnung und nicht das Studium (die Zerblätterung) eines Buches. Wer Allâh bittet, dem gewährt er schöne Belohnung ; denn er ist gütig, aber auch furchtbar.

Die Ruchâma soll aus einem harten, ebenmässigen Körper sein; es empfiehlt sich, seine Breite 2/3 der Länge anzunehmen, damit sich seine Figur schön ansieht. Man mache die Fläche von rechteckiger Form und halbiere sie durch die Linie AB, welche die Mittagslinie für den Ort darstellt; dabei ist A der Nord =, B der Südpunkt.

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(1) In der Fig. 3 ist YY_1 absichtlich etwas tiefer gelegt, damit HU genügend lang wird.

Darauf markiere man durch den Punkt C den Pol der Ruchâma; er liegt auf der Mittagslinie, aber entgegengesetzt der Polhöhe. Ferner nehme man auf derselben Linie, von C abgewandt, also gleichsinnig mit der Polhöhe, einen beliebigen Abstand an, der durch die Marke D fixiert sei. Durch D legen wir eine Senkrechte zur Nordsüdlinie; sie stellt das Bild des Aequators (Widders) dar. Jetzt halbieren wir die Entfernung zwischen Pol und Widder auf der Mittagslinie. Um den Mittelpunkt H beschreiben wir einen Kreis, der durch C und D geht. Von D aus tragen wir auf dem Umfang des Kreises die doppelte Gradzahl der Ortsbreite ab und gewinnen damit den Punkt R. Durch ihn legen wir eine Senkrechte zur Mittagslinie; sie möge in G getroffen werden. Dann ist GR die Länge des Schachs (Schattenstiftes) und G sein Fusspunkt. *Der Schachs steht senkrecht auf der Basiṭa.*

Nunmehr setzen wir den einen Zirkelfuss in den Punkt D, wobei die Oeffnung unverändert, d. h. gleich der doppelten Polhöhe, geblieben ist, und machen auf der Mittagslinie mit dem anderen die Marke T; sie ist der Mittelpunkt des Kreises der Meridiandistanzen (Stundenwinkel). Wir beschreiben um T den Kreis JKL mit irgend einem Radius, der eine passende Länge hat, wie sie dem Bedürfnis entspricht. Den Umfang dieses Kreises teilen wir in gleiche Teile ein, wobei wir die Gradzahl vom Durchschnitt des Kreises mit der Mittagslinie an zählen, d. h. vom Punkte K aus, fortschreitend nach beiden Seiten, jedoch nur so weit als nach der Erfahrung nötig ist (1). Dann übertragen wir diese Teile auf den Kreis (Abbild) des Widders, indem wir jeden Teil mittels des Lineals geradlinig mit dem Kreismittelpunkt verbinden und im Schnittpunkt dieser Geraden mit dem Widder je eine Marke machen. Wir machen dies mit allen vorhandenen Teilpunkten. Und nun verbinden wir alle diese Marken mit dem Pol durch gerade Linien : *das sind die Linien der Stundenwinkel (Stundenlinien) für den in Frage kommenden Ort.*

Bemerkung : Wenn die Ermittlung einer Marke von den Marken, die auf dem Abbild des Aequators sind, schwierig (zu schwer) ist, um sofort bestimmt werden zu können, so konstruiere ein anderes Aequatorbild, nahe bei ihm, und mache das, was oben angegeben worden ist : es ergibt sich das Gewünschte.

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(1) Nämlich im Betrage des halben Tagesbogens der Sonne am längsten Tage.

Bemerkung : Wenn du Stundenlinien zu Stundenwinkeln, die grösser als 90° sind, ziehen willst, so lege das Lineal im Pol R (1) auf eine Linie; es wird ihr Abstand von 90° in dem gewohnten Gradmass die Vermehrung über 90° darstellen; du ziehst die Linie durch den Pol, und indem sie auf der anderen, ich meine auf der entgegengesetzten, Seite herauskommt, liefert sie das Gewünschte.

Nunmehr stellst du für die Ruchâma einen Schattenzeiger aus Eisen, Kupfer oder dergleichen auf; seine Länge sei gleich dem Betrage, den wir auf andere Weise schon konstruiert hatten; wir lassen ihn in die Ruchâma ein an der Stelle seines Fusspunktes, und senken hinab in sie das Heft (sajalân) des Schach es, und nun prüfen wir seine Rektangularität und befestigen ihn mit geschmolzenem Blei (Zinn) oder etwas ähnlichem.

Was aber die Aufstellung der Ruchâma an irgend einem von dir gewollten Ort anbetrifft, so orientiere sie genau nach den 4 Weltgegenden; auch ist es passend, diese Ruchâma auf eine erhöhte Stelle zu platzieren, damit die Sonnenstrahlen zu ihr gelangen können, und wo ihre Fläche dem Horizont parallel ist. Dann planieren wir sie mit einer Maurerkelle oder dergleichen. Der Pol der Ruchâma liegt auf der der Polhöhe entgegengesetzten Seite. Dann beobachte die Sonne, bis dass ihre derzeitige Höhe der Höhe ohne Azimut (2) gleich ist. Lasse einen Faden herabhängen, daran ein Bleilot ist. Und du bewegst die Ruchâma leicht, unter Wahrung ihres Parallelismus zum Horizont, bis dass der Schatten des Fadens auf den Kreis des Widders fällt : es wird die Ruchâma nach den 4 Himmelsrichtungen orientiert sein. Und wenn du willst, so lässt du den Schatten des Fadens auch über die Mittagslinie, zur Zeit des Zawâl, hinstreichen : sie ergibt sich auf diese Weise. Nunmehr befestigst du die Ruchâma an (auf) dem Gebäude mittels Gips oder etwas ähnlichem; die Prüfung ihres Funktionierens geschieht durch Verwendung von Instrumenten, und wenn du Uebereinstimmung erzielt hast, so ist die Aufstellung der Ruchâma richtig, ebenso ihre Lineatur. Zeigt sich aber keine Uebereinstimmung, so kontrollierst du die dargelegten Praktiken nochmals, wegen der Möglichkeit eines Irrtums oder eines sonstigen unvorhergesehenen Umstandes, doch Allâh weiss es am besten.

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(1) Es sollte richtig heissen : im Punkte T.

(2) Die Höhe, die kein Azimut hat, fällt nach arabischer Auffassung in den Ostwestkreis (1. Vertikal). In diesem Augenblick muss also auch der Schatten eines lotrechten Fadens in der Ostwestlinie liegen, und diese ist auf der Ruchâma durch des Abbild des Widders gegeben

Abschnitt über das Ziehen der Stundenlinien auf einer Vertikaluhr auf geometrische Weise.

Dazu haben wir nichts anderes nötig als die Kenntnis des Inḥirâfs und der geographischen Breite des Ortes. Der Gang der Konstruktion ist der, dass wir die Linie des Horizonts, AB, ziehen und auf ihr die Senkrechte GD errichten, welches die Mittagslinie ist. Ferner sei H der Durchschnittspunkt der beiden Geraden. Darauf zeichnen wir auf (über) der Linie des Horizontes einen indischen Kreis : er ist der Kreis des Inḥirâf. Sein Mittelpunkt ist dadurch gegeben, dass sein Umfang durch die Punkte H und U gehen muss. Dabei ist U der Horizontalpunkt des Aequators und H der Durchschnitt der Horizontalen (AB) mit der Nordsüdlinie. Oeffne hierauf den Zirkel bis zur doppelten Gradzahl des Inḥirâf (2α), setze mit dem einen Zirkelfuss im Horizont des Widders (U) ein und mache mit dem anderen Fuss auf dem Kreisumfang die Marke R, und zwar über dem Horizont, wenn der Inḥirâf mit der Seite (Richtung) der Breite verschiedensinnig ist, sonst unterhalb, und fälle von ihr ein Lot auf den Horizont. Dies trifft ihn in C, dem Fusspunkt des Gnomons. Die Länge des Schattenstiftes ist = CR. Oeffne jetzt den Zirkel bis zur Ergänzung der doppelten Gradzahl des Inḥirâf, d. i. arc HR, setze den einen Zirkelfuss in H ein und mache mit dem anderen auf der Linie des Horizontes die Marke T. Sie ist der Mittelpunkt des Kreises der Breite (RJHKU). Beschreibe um T mit derselben Zirkelöffnung (HR = TH = TR) einen indischen Kreis. Oeffne alsdann den Zirkel bis zur Gradzahl der Breite (φ), setze den einen Zirkelfuss in H ein und mache mit dem andern auf dem Umfang des Kreises die Marke J nach oben, und nach unten mit der Zirkelöffnung des Komplements der Breite (90° — φ) das Merkmal K, und dies, wenn der Inḥirâf mit der Breite verschiedensinnig ist, sonst ist es umgekehrt. Ziehe hierauf von T zwei gerade Linien : die eine bis nach J, die andere bis nach K, und verlängere jede derselben : die erste wird die Linie der Tagesmitte in S schneiden, sie ist der Durchmesser des Inḥirâf; die zweite aber wird ihr in N begegnen, dem Zawâl des Widders, der auch Schatten der 6. (Stunde) heisst. Wenn du jetzt C mit S und ebenso U mit N verbindest und CS bis zum Durchschnitt mit UN verlängerst, so treffen sich beide Geraden in L unter einem rechten Winkel. Dann ist die erste Gerade die Mittagsstundenlinie der Uhrfläche, die zweite aber das Abbild des Aequators. Nimm den Betrag der Länge des

Schachs CR in den Zirkel, setze das eine Bein in den Punkt L, das andere auf das Bild des Widders, nach der von dir beliebig gewählten Richtung, in dieser dadurch erhaltenen Marke setzest du den Zirkel ein und spannst ihn, bis er nach C, dem Fusspunkt des Gnomons, fällt; diese Zirkelöffnung nennt man Durchmesser (Hypotenuse). Dann stellst du den Zirkel in der verbleibenden Oeffnung mit einem Fuss in den Punkt L und machst mit dem anderen auf der Linie der Tagesmitte der Uhrfläche die Marke M : sie ist der Mittelpunkt des Stundenkreises. Zeichne diesen Kreis, teile ihn in gleiche Teile ein, indem du mit der Teilung beim Punkte N oder aber auch beim Punkte U anfängst (1), zwischen beiden Anfängen liegt ein Viertelkreis, ich meine in Teilen, deren 15 auf eine Stunde gehen. Nun legst du die Kante des Lineals genau auf den Mittelpunkt M des Stundenkreises und jeden Teil seines Umfangs und markierst jedesmal die Stelle, wo diese Kante das Abbild des Widders durchsetzt. Diese Stellen verbindst du insgesammt durch gerade Linien mit dem Pol. Sie münden nach herkömmlichem Gebrauch gewöhnlich bis zur Ausdehnung eines rechten Winkels (von der Linie der Tagesmitte der Uhr gerechnet) in den Pol ein. Das sind die Stundenlinien, doch Allâh weiss es am besten.

Und zum Schluss bemerke ich folgendes :

Falls du dich der Richtigkeit der Ausführungen durch den Beweis versichern willst, so teile die Länge des Schachs nach den Teilen des Masses des Lineals. Dann konstruierst du den ẓill mabsûṭ (ebenen Schatten, Kotangente, d. h. $= q.\ \mathrm{cotg}\ \alpha$) mit dem Betrage HC; ebenso den ẓill mankûs (gewendeten Schatten, Tangente $= q.\ \mathrm{tang}\ \alpha$) = UC. Alsdann ermittelst du den Schatten des Pols, der $= q.\ \frac{\mathrm{tang}\ \varphi}{\sin \alpha}$ ist (SH), und ebenso den Schatten des Zawâl des Widders, der $= q.\ \frac{\mathrm{cotg}\ \varphi}{\sin \alpha}$ ist (HN).

Ferner ist :

$$\text{sin. der Höhe des Pols} = \sin \alpha.\ \cos \varphi \left(= \frac{q}{\mathrm{RS}} \right)$$

und $\qquad \text{cos. der Höhe des Pols} = \frac{q}{\mathrm{RM}}$ (2),

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(1) d. h. bei dem Punkte, den die Verbindung von M mit N oder N mit U aus der Peripherie des Stundenkreises ausschneidet.

(2) Diese Relation vermag ich nicht zu verifizieren.

und wisse, dass das, was beide (Kapitel) lehren, auch durch die Rechnung verifiziert werden kann ; die vollkommenste Sicherheit gibt der (geometrische) Beweis, und Gott weiss es am besten. »

II

Der 2. Teil meiner Studie enthält die Uebersetzung des Textes von dem Mscr. Bodl. Or. 434, das, wie schon erwähnt, Sibṭ al-Mâridînî zum Verfasser hat. Auch hierzu ist es angezeigt, einige Bemerkungen vorauszuschicken :

a) In den ersten einleitenden Sätzen sagt der Verfasser, dass er Tafeln zur Konstruktion der Stundenlinien erst von 21° Neigung an (Inḥirâf) bis zur Neigung (Deklination) 90° berechnet hätte, weil die Zifferblätter von weniger als 21° Abweichung unter dem Nachteil der unbequemen Konstruktion der Stundenlinien litten und deshalb von den Menschen nicht gewählt würden. Der Autor gibt aber trotzdem Tafeln für alle Abweichungen der Munḥarifât von 1° bis zu 90°. Hieraus und aus einem anderen noch zu erwähnenden Umstand ist der Schluss zu ziehen, dass die Tafeln zu einer anderen (späteren) Zeit entstanden sein dürften als der Text. Ich habe deshalb in der Uebersetzung den Satz ausgelassen, der im Widerspruch mit dem Inhalt der Tafeln steht.

b) In Fig. 4 seien die Zusammenhänge zwischen den beiden Gnomones CR und SR, sowie den vorkommen den Strecken und Winkeln nochmals deutlicher zum Ausdruck gebracht. Hier sei noch eine Bemerkung zur « Höhe des Pols » nachgetragen : Sie ist als $\sphericalangle \gamma$ in dem bei C rechtwinkligen Dreieck RCS enthalten. Aus demselben liest man ab :

$$\sin \gamma = \frac{CR}{SR} = \frac{q}{\frac{q}{\sin \alpha . \cos \varphi}} = \sin \alpha . \cos \varphi .$$

c) In den am Schluss gegebenen Tafeln (ich habe 10 ausgewählt, darunter die mit dem Inḥirâf 53°, welche Zahl das Azimut der Qibla für Kairo ist) fällt nun auf, dass

1. alle Zahlen sich auf einen Gnomon von $q = 12^p$ beziehen und nicht auf 60^p, wie der Text behauptet,

2. dass die Konstruktion der Stundenlinien, wie sie im II. Kapitel des Textes gelehrt ist, mit dem Zahlenmaterial der Tafeln nicht ausgeführt werden kann, dass vielmehr die Entfernung (al-buʿd), wie sie

sich in den Tabellen findet, die Schattenlänge des Azimutes ist, welches die Sonne bei einem gegebenen Stundenwinkel im Aequator hat. Mit anderen Worten : al-bu'd wird auf dem Horizont AB (Fig. 3) abgelesen, wobei der Fusspunkt C Nullpunkt ist. Steht die Sonne

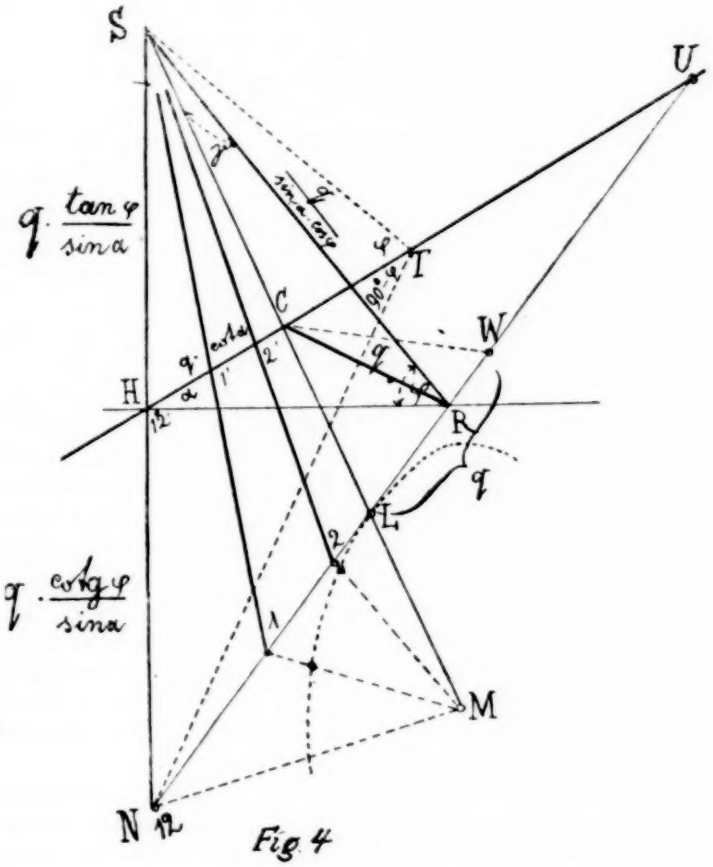


Fig. 4

z. B. in σ, so ist ihr Azimut inbezug auf die Ebene AZB = $B\sigma_1$ = α − Δα, mithin

$$\text{al-bu'd} = CV = q \cdot \operatorname{cotg}(\alpha - \Delta) \quad . \quad . \quad . \quad . \quad . \quad . \quad 1$$

Diese Grösse $\Delta\alpha$ lässt sich aus dem rechtwinkligen sphärischen Dreieck $Z\sigma Q_1$ berechnen : Es ist nämlich :

$$\operatorname{cotg} \Delta\alpha = \sin \varphi . \operatorname{cotg} \operatorname{arc} \sigma Q_1$$

oder für den Stundenwinkel $Q_1\Sigma = s$:

$$\operatorname{cotg} \Delta\alpha_1 = \sin \varphi . \operatorname{cotg} s \quad . \quad . \quad . \quad . \quad . \quad . \quad \text{II}$$

Es ist selbstverständlich, dass wenn $\Delta\alpha$ von α abzuziehen ist (Vormittag), dann $\Delta\alpha_1$ zu α nach dem Zawâl zu addieren ist.

Will man also al-bu'd in einer Formel ausdrücken, deren Argument der Stundenwinkel s ist, so muss man $\operatorname{cotg}(\alpha \pm \Delta\alpha)$ nach dem Additionstheorem entwickeln und man erhält, unter Berücksichtigung von II,

für die Zeit vor dem Zawâl :

$$\text{al-bu'd} = q . \frac{\operatorname{cotg} \alpha . \sin \varphi . \operatorname{cotg} s + 1}{\sin \varphi . \operatorname{cotg} s - \operatorname{cotg} \alpha} \quad . \quad . \quad . \quad . \quad . \quad \text{III}$$

für die Zeit nach dem Zawâl :

$$\text{al-bu'd} = q . \frac{\operatorname{cotg} \alpha . \sin \varphi . \operatorname{cotg} s - 1}{\sin \varphi . \operatorname{cotg} s + \operatorname{cotg} \alpha} \quad . \quad . \quad . \quad . \quad . \quad \text{IV}$$

Man braucht also nur aus den Tafeln das dem Stundenwinkel s zugehörige « al-bu'd » (bei gegebenem Inḥirâf) zu entnehmen, von C aus in der sinngemässen Richtung abzutragen, und die auf dem Horizont erhaltenen Punkte (z. B. V) mit dem Pol S zu verbinden, so hat man die gewünschten Stundenlinien (z. B. SV). Sibṭ al-Mâridînî wählt Stundenwinkel von 5° zu 5°, die also 20 Zeitminuten entsprechen. Wie ein Blick auf die Uhrebene AZB zeigt, vermag bei diesem Inḥirâf die Uhr nach dem Zawâl viel länger der Zeitmessung zu dienen als Vormittags. In jedem Falle gibt der Autor auch die Grössen HN und HS an. Die Breite φ ist durchweg 30°.

Gerne erwähne ich an dieser Stelle der anregenden mündlichen Beratungen mit Herrn Professor Jo. Drecker in Dorsten (i. Westfalen), die mir besonders bei der Frage des Polos von grossem Werte waren.

Uebersetzung.

Im Namen Allâhs, des barmherzigen Erbarmers! Lob sei Gott, dem Herrn der Welten! Der Segen Allâhs ruhe auf Muhammed, seiner Familie und der Gemeinschaft aller! Es sprach der arme

Knecht (1) — möge sein Herr sich seiner erbarmen — MUḤAMMED SIBṬ AL-MÂRIDÎNÎ : Ich habe diese Tafeln berechnet über das Verzeichnen deklinierender Vertikaluhren über Mauern auf leichte und schöne Art, zu der ich erst jetzt gelangt bin. *Sie besteht in der Ermittlung der Richtung der Stundenlinie (ihres Azimuts) bezüglich der Linie des Zawâl;* und ich tätigte dies vom Inḥirâf 1° bis zum Inḥirâf 90°, wobei die Abweichung gradweise fortschreitet. Es ist angezeigt, diesen Tafeln die nötigen Erörterungen vorauszuschicken. Wir bringen diese in 3 Kapiteln.

I. KAPITEL.

Ueber die Definition des Munḥarif und die Kenntnis seines Inḥirâf.

Der Munḥarif ist eine ebene Fläche, die auf der Ebene des Horizontes senkrecht steht. Und das erste Erfordernis ist das, dass du die vollkommene Ebenmässigkeit der Mauer (Wand, Auffangfläche) feststellst, auf der du die Lineatur entwerfen willst. Dazu legst du das Ende eines fehlerlosen Lineals auf die Wand und drehst es im Kreise herum ; und wenn es sich nach jeder Richtung mit ihr deckt, so ist dieselbe ganz eben und glatt, sonst verderbt ; und siehe, est ist leicht möglich, dass man sie mit irgend einem Instrument gleichmässig eben macht oder mit Gips oder etwas ähnlichem. Führe es aus! Falls du das dazu Nötige nicht hast, so lasse es und sieh dich nach etwas anderem um. Zur Prüfung des Senkrechtstehens der Wand ist es unumgänglich nötig, dass du sie mit der Architektenwage nivellierst. Ein bekanntes Verfahren ist das, dass du die eine der 2 Seiten des Quadranten an die Wand anlegst und am Faden desselben das Bleilot aufhängst. Wenn alsdann der Faden eine Linie einnimmt, die jener Seite des Quadranten parallel ist, so ist die Rectangularität der Wand fehlerlos richtig. Du lässt also das Bleilot an einem Faden herab und näherst deine Hand der Wand, und wenn der Abstand des Fadens von oben bis unten ein und derselbe ist, sie ist sie genau senkrecht. Doch es gibt noch zahlreiche (andere) Verfahren zur Prüfung des Vorhandenseins dieser Bedingung, und falls die Wand

(1) Das arab. Mscr. hat deutlich : « faqir » (arm). Ich möchte eher lesen ; « faqîh » (gelehrt).

richtig ist und genau perpendikulär steht, so kommen wir zur *Ermittlung ihres Inḥirâf*, d. i. ihres Winkelabstandes von der Mittagslinie, und man muss zwischen der Nord-Süd- und Ost-Westrichtung unterscheiden. Ermittle den Inḥirâf in der Weise, dass du die eine Seite des Quadranten gegen die Mauer stützest; die Nähe des Zawâl ist dort, wo die Sonne die ihm entsprechende Höhe zeigt, und die (andere) Seite des Quadranten ist dadurch dem Horizont parallel, dass du sie auf den ebenen Boden oder auf eine ausgebesserte Stelle an dem Orte stellst, wo du deine Ausführungen machen willst. Hänge darauf das Bleilot am Faden auf; es geht sein Schatten über den Mittelpunkt und Umfang des Quadranten, wenn beide (Schatten und Quadrant) gleichgerichtet sind. Was nun zwischen seinem Schatten und der Wand an Bogen der Höhe ist, das ist der Betrag des Inḥirâf. Die Bedingung bei diesem Verfahren ist die, dass der Strahl der Sonne auf den Mittelpunkt des Quadranten fällt, gleichviel, ob die Front der Wand besonnt oder beschattet ist; er (der Schatten?) verdeckt aber den Mittelpunkt nicht, wenn die Belichtung (des Fadens?) schwach ist; falls er bis dorthin gestreckt ist, wo er den Mittelpunkt verdeckt, so ist dieses Verfahren an diesem Tage (zu) schwierig (1). Bediene dich alsdann eines anderen, oder du beobachtest an einem anderen Tag, es sei denn, dass du eine Abhilfe ersinnest, wie in dem Falle, wo du sie fandest für das Ebenmachen zweier parallelen Flächen. Du führst sie (die Abhilfe, Verbesserung?) zwischen dem Quadranten und der Wand aus, an der Stelle, wo es dem Sonnenstrahl möglich ist, in diesem seinem Zustande auf den Mittelpunkt des Quadranten zu fallen, und das ist nicht schwierig, vielmehr vervollständigst du das Verfahren wie im Vorhergehenden.

Ein anderes Verfahren, das sich der Ziehung der Mittagslinie auf dem Boden in der Nähe der Wand bedient, beruht auf der bekannten Methode der Bestimmung der Weltgegenden und der Qibla. Wir verlängern sie (die Mittagslinie), bis dass sie die Wand trifft, und wenn sie lotrecht auf der Wand steht, so dass du auf beiden Seiten der Mittagslinie 2 gleich grosse Winkel missest, so ist der Inḥirâf = 90°; wenn sie aber nicht senkrecht auf der Wand steht, sondern so, dass du 2 verschiedene Winkel feststellst, so missest du den kleineren von beiden; er ist immer der Winkel des Inḥirâf, weil es nicht möglich ist, ihn über 90° hinaus zu vermehren. Und nun ermittle den Betrag

(1) Der Inhalt dieses Satzes ist mir nicht verständlich.

seines (des Inḥirâf) Bogens, dadurch dass du ihn in die Oeffnung des Zirkels spannst, die dann bekannt wird. Du setzest seinen Fuss auf die Spur der Wand, die näher (zur Mittagslinie) liegt, und diese Zirkelspannung gibt den Bogen des Inḥirâf. Nimm diesen Bogen in der Weise in den Zirkel, dass eines seiner Beine in einem, das andere im anderen Ende des Winkels steht. Versetze darauf den Zirkel auf jenen Kreis, auf welchem dieser Bogen geprüft (verglichen) wird. Dann findest du das Verlangte (nämlich den Inḥirâf) und zwar so, dass du mit der bekannten Zirkelöffnung einen Kreis zeichnest, denselben mit den Teilen des astronomischen Kreises versiehst und jeden dieser Teile deutlich sichtbar machst. Vorbedingung für das Verfahren ist, dass der Boden gleichmässig eben und fehlerfrei ist. Fürs Erste bestreichst du ihn zu seiner Ausbesserung mit Lehm, und so wird er eben; alsdann verklebst du die Ränder mit der horizontalen Kante der Wand, und nun nivellierst du ihn mit Wasser oder etwas anderen, bis dass er dem Horizonte genau parallel ist. Nunmehr ziehst du auf ihm die Linie des Mittags. Es sei zur Vervollständigung noch ein drittes Verfahren erwähnt : Nimm die (Sonnen-) Höhe zur Zeit des Verdunkelns der Front der Wand, falls sie vorher hell und besonnt war. Und wie sie nun in den Schatten taucht, so wisse das augenblickliche Azimut dieser Höhe aus den Azimuttafeln; was du findest, das ist die Ergänzung des Inḥirâfs der Wand; du ziehst sie von 90° ab, und es bleibt der Inḥirâf selbst, und so ergibt sich das Gesuchte.

Und was die (Himmels-) Richtung anbelangt, so beobachte die Front der Wand zur Zeit des Zawâl, und wenn sie besonnt ist und wir verstehen unter ihrer Richtung die Richtung ihrer Spur, so setzen wir (ganz allgemein) diese Richtung, wie folgt, fest : Falls die Spur nach Norden zu weist mit ihrer äussersten Grenze, so ist die Richtung nördlich, falls sie aber nach dem Süden weist, ist die Richtung südlich. Und wenn die Wand beschattet ist, so ist die Richtung entgegengesetzt der eben gegebenen Festsetzung. Und wenn die äussere Grenze der Wand die Richtung 90° (zu der des Zawâl ?) hat, so ist die Determinierung der Front unmöglich (sehr schwierig). Du kannst dich aber auch der Wand gegenüberstellen : falls dann der Osten zu deiner Rechten liegt, so ist der Inḥirâf südlich, und wenn er zu deiner Linken liegt, so ist der Inḥirâf nördlich und beachte auch, dass, falls des Süden zu deiner Rechten liegt, die Wand östlich ist, und wenn er zu deiner Linken liegt, so ist sie westlich, und du kennst also die Richtung der Wand, doch Allâh weiss es am besten.

II. Kapitel.

Ueber die Ziehung der Stundenlinien auf den Munḥarifât.

Du hängst am Faden des Quadranten ein Bleilot auf und näherst ihn der Wand so, dass seine Oberfläche auf die Front der Mauer kommt; dann bewegst du den Quadranten, bis dass sein Faden eine Linie bedeckt (in einer Vertikallinie ist). Du legst die Kante des Lineals auf sie und ziehst eine gerade Linie bis zum unteren Ende des Lineals : Das ist die Linie des Zawâl. Sie möge eine passende Lage auf der Wand haben. Nimm alsdann das Lineal, das in gleiche Teile geteilt ist, öffne den Zirkel und greife damit 60 Teile auf ihm ab. Du setzest den Fuss des Zirkels auf eine Stelle der Linie des Zawâls, die du « Pol » nennst. Mit dem anderen Zirkelfuss beschreibst du einen Halbkreis oder einen noch grösseren Bogen, gemäss deinem Gutdünken, der die Linie des Zawâl durchschneidet. Jetzt schlägst du die Tafel des Inḥirâf der Wand auf und beachtest, was an Zahlen der Azimute (1) dem Faḍl ad-dâ'ir (Stundenwinkel) gegenübersteht, Zahlen, die in der rechten Kolumne der Tafel des Inḥirâf stehen. Oeffne den Zirkel bis zum Betrag jener Zahl in Teilen des Lineals, stelle darauf einen Fuss auf den Durchschnitt des Kreises mit der Linie des Zawâl und mache mit dem anderen Fuss auf dem Kreise eine Marke, unter Berücksichtigung eines nördlichen oder südlichen Inḥirâf : Das ist die Marke des Stundenwinkels. Mache dasselbe mit allen Zahlen, die den Stundenwinkeln von 5°, 10°, 15°. . . bis 90° gegenüberstehen. Dann verbindest du alle diese Marken durch gerade Linien mit dem Pol : das sind die Stundenlinien. Ist der Inḥirâf östlich, so sind diese Linien westlich (vom Zawâl); man erkennt aus ihnen die seit dem Zawâl verflossene Zeit; und wenn der Inḥirâf westlich ist, so sind diese Linien östlich; man erkennt aus ihnen die Zeit, die bis zum Eintritt des Zawâl noch übrig bleibt. Falls du auch die anderen Linien einlegen willst, so musst du bei dem Inḥirâf der westlichen Linien die seit dem Zawâl verflossene Zeit wissen und beim Inḥirâf der östlichen die bis zum Eintritt des Zawâl noch restierende Zeit. Oeffne den Zirkel, mit den Beträgen der Teile des Lineals, welche den Entfernungen entsprechen, die du in der linken Kolumne aus der Tafel des Inḥirâf findest für den von dir gewoll-

(1) hier stünde wohl besser : Entfernungen (Schattenlängen).

ten Wert des Gradbogens. Dann stellst du den einen Fuss des Zirkels in den Durchschnitt des Kreises mit der Linie des Zawâl und machst mit dem anderen eine Marke auf dem Kreis und zwar nach der dem Inḥirâf entgegengesetzten Seite, und mache das für den von dir gewünschten Wert und reihe das Erhaltene an die schon verhandenen Stundenlinien an. Dann verbindest du auch diese Marken geradlinig mit dem Pol. Und wenn du willst, dass diese Linien unterhalb des verdeckenden Fadens sind — wegen ihres paarweisen (geradzahligen) Vorhandenseins bezüglich des Stundenwinkels der Sterne — so nimmst du ihre Mitte und schlägst den höchsten Razz (1) in den Pol, und den tiefsten, der am Boden ist, in eine Stelle, die aus der Mittagslinie ausgeschnitten ist, dort, wo der Faden sein wird, ausser auf dem Durchschnitt mit der Weltachse, und du ergänzest dein Tun.

Und was die Berechnung dieser Tafeln anbetrifft, sowie die Frage wie ich sie hergestellt habe mittels der Sinusrechnung und anderem, das in anderen Ländern der Erde gebräuchlich ist, so habe ich das in meinem Buch, betitelt : « Ǧâmiʿ al-mubaktirât » (2) (Encyclopädie der Frühaufstehenden) ausgeführt, einem Werk über die Bestimmung der Zeiten und das Handhaben der Instrumente; doch Allâh weiss es am besten.

III. Kapitel.

Ueber die Aufstellung des Schattenstiftes (Schachs).

Nimm das Quadrat des Schattens des Inḥirâf und dasjenige der Höhe des Pols und ziehe alsdann das Quadrat des Schattens des Inḥirâf vom Quadrat des Schattens der Polhöhe ab; radiziere die Differenz; was herauskommt, ist die Entfernung des horizontalen Punktes der Fläche von dem (scheitelrecht) über ihm liegenden Pol (3). Nimm diese Entfernung in den Zirkel, indem du sie auf dem geteilten Lineal abgreifst, setze den einen Zirkelfuss in den Pol und mache mit dem andern ein Zeichen auf der Linie des Zawâl, und zwar unterhalb des Pols, wenn der Inḥirâf südlich ist, und oberhalb des-

(1) Ich kenne den Sinn dieses Substantives nicht; vermutlich dürfte es aber mit dem Verbum razza = eine Sache in eine andere stecken, zusammenhängen. Der ganze Satz ist mir inhaltlich nicht klar.

(2) Scheint nicht mehr zu existieren.

(3) danach ist CS der Schatten der Polhöhe (Fig. 4).

selben, wenn er nördlich ist. So ergibt sich der horizontale Punkt der Fläche. Ziehe von ihm eine gerade Linie in der Richtung des Inhiråf : sie steht senkrecht auf dem Zawâl und ist der Horizont der Uhrfläche. Nun öffnest du den Zirkel und greifst auf dem geteilten Lineal die Länge des Schattens des Inhiråf ab, setzest seinen Fuss in den Durchschnittspunkt der Horizontalen der Fläche mit der Linie des Zawâls und machst mit dem anderen Fuss eine Marke auf der Horizontalen : sie ist der Fusspunkt (Standpunkt) des *kleineren Schattenstiftes*, dessen Länge 12 Teile (partes) ist, bezüglich der Teile des Lineals, ohne das Heft, welches in die Wand eingelassen ist. Du setzest diesen Schachs auf seinen Fusspunkt, wählst aber auch einen *längeren Miqjâs* (Schattenmesser), dessen Länge du dir nicht von vorneherein gibst, sondern du errechnest für ihn eine passende (elegante) Länge. Dann platzierst du ihn in den Pol, und dies ist also der längere Schachs. Und du neigst ihn auf die Spitze des kürzeren, wo er mit ihm . . . . . (1) in einem Punkt (d. h. der längere Gnomon), ist er ein Stückchen (Ausschnitt) der Himmelsachse in diesem Augenblicke, falls wir voraussetzen, dass sie den Himmel durchsetzt nach beiden Seiten, weil sie bis zu den Weltpolen reicht. Doch dies ist nur hypothetisch so, und nicht die Wirklichkeit. Für dich ergibt sich nun die Aufgabe, dem kleineren Gnomon einen Ring auf die Spitze zu machen, durch den du den längeren hindurchsteckst, damit er auf den kleineren gestützt sei, aber unter der Bedingung, dass die Mitte des Ringes, d. i. die Spitze des kürzeren Schachs, sich genau mit der Mitte des grösseren in einem Punkte deckt; du musst daher den kürzeren ganz dünn machen und den längeren in die Stelle ihres Zusammentreffens einlassen. Du kannst aber auch die Spitze des kürzeren in den längeren einlassen, vorausgesetzt, dass sie einen Punkt gemeinsam haben. Begnügst du dich mit dem kürzeren Gnomon, so gibt er mit seiner Spitze auf den (Stunden-) Linien besonders gute Schattenbilder, aber es verlängert sich sein Schatten an den langen Tagen in der Nähe des Zawâl, dort wird er dann sehr lang. Es ist deshalb notwendig, dass du auch die Stundenlinien verlängerst. Das Schönste ist, dass du den längeren aufstellst, wie du es eben kennen gelernt hast, *denn sein Schatten geht ganz über die Linien hin* (2); dann musst du dich mit ihm begnügen; aber das Beste ist,

(1) Wort unleserlich. Der Sinn des Wortes dürfte sein : zusammenstösst.

(2) Dies ist der Vorzug des Polos vor dem Schachs, der senkrecht zur Uhrfläche steht.

dass du ihn zusammen mit dem kürzeren aufstellst, und dieser möge auf ihm ruhen; du musst dann *vor* der Konstruktion der Linien der Stundenwinkel den Fusspunkt festlegen, und das ist schöner und leichter. Das Verfahren ist dies : Du ziehst die Linie das Zawâl, wie ich es gelehrt habe, errichtest auf ihr eine Senkrechte, parallel dem Horizont, oder du ziehst die Linie des Horizontes zuerst und errichtest dann auf ihm die Senkrechte, welches die Linie des Zawâl ist, — und ich erwähnte schon in meinem Buch, betitelt « Fatḥ al-gâdir » (die Hilfe des Allmächtigen) eine Methode, auf einer Linie eine Senkrechte zu ziehen, und zwar bei der Bestimmung des Stundenwinkels, worauf ich verweise — darauf schlägst du die Tafel des Inḥirâfs der Wand auf, öffnest den Zirkel und greifst auf dem geteilten Lineal den Betrag des ẓill-mabsûṭ (Kotangente) für den Inḥirâf ab, der unten in der Tabelle festgesetzt ist. Dann stellst du den einen Fuss des Zirkels in den Durchschnittspunkt der Linie des Horizonts mit der des Zawâl und machst mit dem anderen Fuss eine Marke auf der Linie des Horizontes, und zwar in der Richtung der Abweichung von Norden und Süden : diese Marke ist der Standpunkt des kleineren Miqjâs. Oeffne den Zirkel bis zum Betrage des ẓill-mabsûṭ der Höhe des Pols (Kotangente) der unten in der Tafel angegeben ist, setze seinen Fuss in den Fusspunkt des kleineren Miqjâs und mache mit dem anderen dorthin ein Zeichen, wo er die Linie des Zawâl trifft, und zwar über dem Horizont, wenn der Inḥirâf südlich ist, und unter demselben, wenn er nördlich ist : das ist der Pol. Nunmehr greifst du mit dem Zirkel 60 der Teile des Lineals ab und beschreibst mit dieser Zirkelöffnung als Radius einen Kreis, Halbkreis oder auch mehr, je nach deinem Gutdünken. Dann bestimmst du die Punkte der Azimutabstände (Entfernungen) wie ich es gezeigt habe und führst dies bis zum letzten (äussersten) Punkt durch. Darauf stellst du den kleineren Schachṣ im Fusspunkt, den längeren aber im Pol auf, gemäss dem, was vorausging, und du vervollständigst und ergänzest den Munḥarif, und dies ist das Letzte, was wir darlegen wollten in dieser Studie. Es folgen jetzt die Tafeln.

1. *Tafel des Munḥarif 10°.*

Schatten des Pols: 39p54′			
Schatten d. Zawâl ☉: 119p41′			
Stunden-winkel	al-bu'd		Rich-tung
	p	′	
0°	68	3	nördl.
5	33	6	n
10	21	17	n
15	15	15	n
20	11	33	n
25	9	3	n
30	7	11	n
35	5	44	n
40	4	33	n
45	3	34	n
50	2	43	n
55	1	58	n
60	1	18	n
65	0	40	n
70	0	4	n
75	0	30	südl.
80	1	3	s
85	1	35	s
90	2	7	s

2. *Tafel des Munḥarif 20°.*

Schatten des Pols: 20p15			
Schatten d. Zawâl ☉: 60p46′			
Stunden-winkel	al-bu'd		Rich-tung
	p	′	
0°	32	58	nördl.
5	20	51	n
10	14	36	n
15	10	44	n
20	8	5	n
25	6	7	n
30	4	34	n
35	3	20	n
40	2	17	n
45	1	23	n
50	0	35	n
55	0	9	südl.
60	0	48	s
65	1	26	s
70	2	3	s
75	2	38	s
80	3	13	s
85	3	47	s
90	4	22	s
5°	67	38	nördl.

3. *Tafel des Munḥarif 30°.*

Schatten des Pols : 13P51′			
Schatten d. Zawâl ☿ : 41P34′			
Stundenwinkel	al-bu'd		Richtung
	P	′	
0°	20	47	nördl.
5	14	20	n
10	10	16	n
15	7	27	n
20	5	20	n
25	3	40	n
30	2	18	n
35	1	10	n
40	0	10	n
45	0	43	südl.
50	1	31	s
55	2	16	s
60	2	58	s
65	3	38	s
70	4	18	s
75	4	56	s
80	5	36	s
85	6	15	s
90	6	56	s
5°	32	51	nördl.
10	64	28	n
15	412	24	n

4. *Tafel des Munḥarif 45°.*

Schatten des Pols : 9P48′			
Schatten d. Zawâl ☿ : 29P24′			
Stundenwinkel	al-bu'd		Richtung
	P	′	
0	12	0	nördl.
5	8	25	n
10	5	45	n
15	3	37	n
20	1	53	n
25	0	25	n
30	0	52	südl.
35	2	0	s
40	3	3	s
45	4	0	s
50	4	55	s
55	5	47	s
60	6	37	s
65	7	27	s
70	8	19	s
75	9	10	s
80	10	3	s
85	11	0	s
90	12	0	s

Stundenwink	al-bu'd		Richtung
	P	′	
5°	17	6	nördl.
10	25	5	n
15	39	46	n
20	76	15	n
25	343	39	n

5. *Tafel des Munḥarif 53°.*

Die Linien, die seit Sonnenaufgang passiert stnd, oder bis zum Untergang verbleiben

Koordinaten des Krebses.						Koordinaten des Steinbockes.					
Verflossen seit Aufgang	al-bu'd		Richtung	az-zill al-mustaʿmil		Verflossen seit Aufgang	al-bu'd		Richtnng	az-zill al-mustaʿmil	
	p	′		p	′		p	′		p	′
0°	72	2	südl.	0	0	0°	5	43	südl.	0	0
5	56	53	s	3	17	5	5	5	s	0	52
10	46	39	s	6	38	10	4	25	s	1	40
15	40	38	s	8	53	15	3	44	s	2	28
20	35	40	s	10	42	20	3	3	s	3	13
25	31	48	s	12	25	25	2	18	s	3	55
30	28	40	s	14	2	30	1	32	s	4	37
35	26	3	s	15	32	35	0	44	s	5	20
40	23	49	s	17	9	40	0	8	nördl.	6	0
45	21	58	s	18	52	45	1	3	n	6	40
50	20	9	s	20	35	50	2	2	n	7	21
55	18	31	s	22	33	55	3	10	n	8	3
60	17	11	s	24	58	60	4	20	n	8	45
65	15	19	s	27	2	65	5	40	n	9	27
70	14	26	s	30	45	70	7	11	n	10	12
75	12	33	s	33	55	75°24′	9	3	n	11	5
80	10	59	s	38	38						
85	9	11	s	44	54						
90	6	59	s	53	36						
95	4	0	s	67	3						
100	0	38	nördl.	90	15						
104°36	9	5	n	104	12						

bu'd für den Horizont des Widders : 15p55′.

Schatten der Zawâl des Widders : 26p2′.

6. *Munḥarif* 53°.

Tafel für die Beträge des ẓill-musta'mil der bis zum 'aṣr bleibenden Bogen.

Krebs				Widder				Steinbock			
Stundenwinkel vor dem 'aṣr	al-bu'd		Richtung	Stundenwinkel vor dem 'aṣr	al-bu'd		Richtung	Stundenwinkel vor dem 'aṣr	al-bu'd		Richtung
	p	'			p	'			p	'	
0	19	56	südl.	0	7	23	südl.	0	0	58	südl.
5	18	19	s	5	6	21	s	5	0	9	s
10	16	43	s	10	5	18	s	10	0	46	nördl.
15	15	34	s	15	4	11	s	15	1	44	n
20	14	3	s	20	3	1	s	20	2	44	n
25	12	24	s	25	1	45	s	25	3	58	n
30	10	43	s	30	0	21	s	30	5	16	n
35	8	51	s	35	1	14	nördl.	35	6	42	n
40	6	33	s	40	3	4	n	40	8	21	n
45	3	22	s	45	5	15	n	45	13	33	n
50	1	45	nördl.	50	7	55	n	50	20	38	n

Diese Proben aus 90 Tafeln des Autors illustrieren deren Aufbau zur Genüge. Während die Tabellen Nos. 1, 2, 3, 4, 7, 8, 9, 10 nach dem Vorausgeschickten sofort verständlich sind, bedürfen Nos. 5 und 6 einiger Erläuterungen: Wie schon oben angedeutet, ist $\alpha = 53°$ Inḥirâf der Qibla für Kairo. Da diese Richtuug an senkrechten Mauern der Moscheen besonders in Frage kommt, so hat Sibṭ al-Mâridînî dem so deklinierenden Zifferblatt auch besondere Aufmerksamkeit zugewandt: Er berechnete für $\alpha = 53°$ die rechtwinkligen Koordinaten einer Anzahl Kurvenpunkte der Abbilder für Krebs und Steinbock. Nach der Tafel No. 5 sind die Bilder der Anfänge der 3 bekanntesten Tierkreiszeichen entworfen. Dabei ist H Koordinatenanfangspunkt; die Abscisse ist das uns längst bekannte «al-bu'd» (die Distanz), die Ordinate eines Punktes (P) heisst: «aẓ-ẓill al-musta'mil» (der gebräuchliche, angewendete Schatten = ombre employée).

In Fig. 5 findet sich auch die sog. 'Aṣr-Kurve (Linie des Nachmittaggebets) eingezeichnet. Bekanntlich ändert sich der Eintritt des 'Aṣr mit der Jahreszeit und der geographischen Breite des Ortes in mathematisch nicht einfacher Weise; so tritt er zu Beginn des Krebses

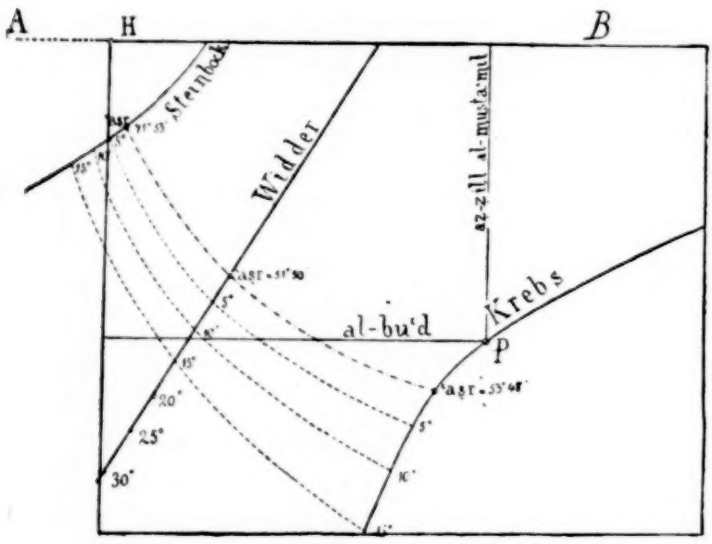


Fig. 5.

(für $\varphi = 30°$) bei einem Stundenwinkel von $s = 53°48'$ (nachmittags) ein; zu Beginn des Widders ist $s = 51°50'$ und endlich zu Beginn des Steinbocks ist $s = 41°33'$, was den Zeiten $3^h35'$, $3^h27'$ und $2^h46'$ entspricht. Ich möchte für nähere Details über 'Aṣr und Qibla auf meine «Gnomonik der Araber» (S. 33-54) verweisen, und hier nur bemerken, dass Tabelle No. 6 die eine Coordinate der Kurven enthält, über die der Schatten des Spitze des Schachs 5°, 10°, 15°. . . 50° *vor* Eintritt des 'Aṣr hingeht. Ich habe dergleichen in der arabischen Gnomonik nirgendwo gefunden. Diese Kurven sind mathematisch noch nicht untersucht.

Endlich bemerke ich noch, dass Fig. 6 die Stundenlinien eines Ostwestvertikals enthält, so wie er sich beim Autor findet.

7. *Tafel des Munḥarif 60°*

Schatten des Pols : 8p0′			
Schatten d. Zawâl ☉ : 24p0′			
Stunden-winkel	al-bu'd		Richtung
	p	′	
0°	6	56	nördlich
5	4	23	n
10	2	14	n
15	0	23	n
20	1	16	südlich
25	2	46	s
30	4	10	s
35	5	28	s
40	6	43	s
45	7	56	s
50	9	8	s
55	10	20	s
60	11	31	s
65	12	48	s
70	14	9	s
75	15	33	s
80	17	7	s
85	18	51	s
90	20	47	s

Stunden-winkel	al-bu'd		Richtung
	p	′	
5°	10	3	nördlich
10	14	1	n
15	19	21	n
20	27	1	n
25	39	15	n
30	62	28	n
35	127	54	n

8. *Tafel des Munḥarif 70°.*

Schatten des Pols : 7P22′			
Schatten d. Zawâl ♈ : 22P7′			
Stunden-winkel	al-bu'd		Richtung
	P	′	
0	4	22	nördl.
5	2	8	n
10	0	7	n
15	1	44	südl.
20	3	27	s
25	5	6	s
30	6	41	s
35	8	14	s
40	9	48	s
45	11	21	s
50	12	59	s
55	14	25	s
60	16	26	s
65	18	28	s
70	20	32	s
75	22	55	s
80	25	42	s
85	28	59	s
90	32	58	s

Stunden-winkel	al-bu'd		Richtung
	P	′	
5	6	55	nördl.
10	9	52	n
15	13	26	n
20	17	49	n
25	23	33	n
30	31	28	n
35	43	13	n
40	63	12	n
45	103	51	n
50	259	33	n

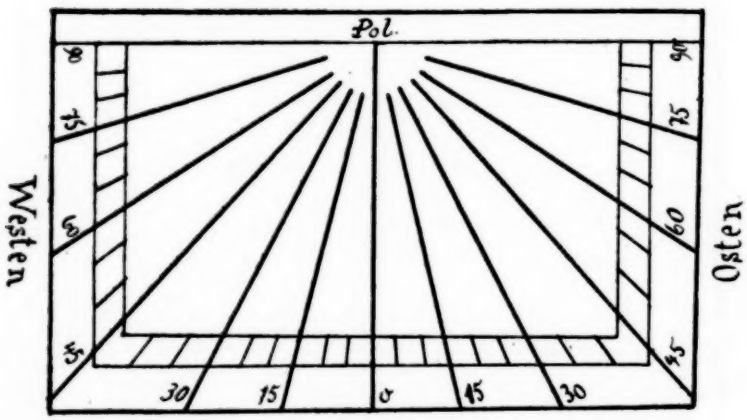
9. *Tafel des Munḥarif 80°.*

Schatten des Pols : 7p2′			
Schatten d. Zawâl ♈ : 21p6′			
Stunden-winkel	al-bu'd		Richtung
	p	′	
0	2	7	nördl.
5	0	1	n
10	2	0	südl.
15	3	57	s
20	5	52	s
25	7	48	s
30	9	45	s
35	11	46	s
40	13	55	s
45	16	11	s
50	18	40	s
55	21	25	s
60	24	27	s
65	28	4	s
70	32	27	s
75	37	43	s
80	44	40	s
85	54	13	s
90	68	3	s

Stunden-winkel	al-bu'd		Richtung
	p	′	
5	4	21	nördl.
10	6	46	n
15	9	15	n
20	12	27	n
25	15	55	n
30	20	4	n
35	25	8	n
40	31	40	n
45	40	23	n
50	53	11	n
55	73	35	n
60	101	42	n
65	220	22	n

10. *Tafel des Munḥarif 90°.*

Schatten des Pols : θ_p56'			Schatten d. Zawâl φ :50°47'		
Stunden-winkel	al-bu'd		Stunden-winkel	al-bu'd	
	p	'		p	'
5°	2	6	50°	28	39
10	4	14	55	34	19
15	6	26	60	41	28
20	8	43	65	51	23
25	11	11	70	66	9
30	13	52	75	89	42
35	16	48	80	136	14
40	20	9	85	286	19
45	24	0	90	—	—



Essen a. d. R. KARL SCHOY.

L'Encyclopédie
and the History of Science

Encyclopedias are perhaps the most important monuments of the history of science and of civilization. Not only do they comprise a wealth of detail brought together with the prime purpose of giving information, so that they are at least less intentionally misleading than many other documents. They also aim to cover the entire field of human interest in their day, so that the argument from silence can be employed in their case with more assurance than in other cases, and some quantitative conclusions may be ventured upon from the way in which their space is apportioned among the different fields of human endeavour, although of course this is to some extent a matter of chance, and the editors of the famous French *Encyclopédie* (1) which is the object of the present study had occasion to

(1) JOHN MORLEY, *Diderot and the Encyclopaedists*, 1878, 2 vols., seems to be still the most comprehensive work on the subject. Most biographies of DIDEROT or other works on him are rather slight or at least contain little to our purpose. M. ROUSTAN, *Les philosophes et la société au XVIII^e siècle*, Université de Lyon, *Annales, Nouvelles série. 1906*, Fasc. 16, does not include science in its scope. R. L. CRU, *Diderot as a Disciple of English Thought*, *Columbia University Studies in Romance Philology*, 1913, shows that DIDEROT was much more indebted to EPHRAIM CHAMBERS' Cyclopaedia of 1728 than he admitted, and also copied a good deal from BRUCHER'S *Latin History of Philosophy*. CRU says at p. 284.

« The great haste and secrecy with which the main part of the Encyclopédie had to be written, especially after the desertion of d'ALEMBERT and of many contributors, the urgent necessity of completing... a work for which the subscribers had paid in advance and in which the fortunes of several booksellers were involved, compelled him (DIDEROT) to finish almost alone a task which today requires the work of hundreds of scholars and scientists. » The part of l'*Encyclopédie* thus characterized is, however, one with which the present article will be little concerned. Indeed, d'ALEMBERT rather than DIDEROT will be our guiding star.

D. MORNET, *Les sciences de la nature en France au XVIII^e siècle*, 1911, (290 pp.) centers its discussion about BUFFON and does not have much to say concerning l'*Encyclopédie*. However, it cites the articles « Experimental » (pp. 75, 77, 86, 92, 136, 148), « Fossiles » (pp. 19, 61), « Scolastique » (p. 77, « Montagnes » (p. 120), « Cabinet d'histoire naturelle » (p. 231), « Hypothèse » (p. 105), « Système » (p. 107). MORNET treats especially of the influence of science on the general reading public.

complain that their contributors often composed articles of a length disparate to the relative importance of the subject treated. Even a one-man compilation such as the *Natural History* of PLINY the Elder appears to be our most comprehensive source for ancient civilization. A modern encyclopedia, to which various authorities in different departments are supposed to contribute, although a certain amount of unintelligent hack-work and repetition of previous encyclopedias may creep in, should, in its many-sided reflection of various aspects of civilization from different points of view, constitute a far more valuable picture of our civilization.

This possibility was well recognized by the editors of the eighteenth century French *Encyclopédie*. DIDEROT in the article « *Encyclopédie* » often adverts to the invaluable handy information which posterity may glean from their work concerning the conditions then prevalent. In defending certain historical disquisitions on such themes as cooking and fashions in clothing, which some readers and critics of the previous volumes had regarded with disfavor, he affirmed, — not perhaps without a touch of that playful irony which gives the *Encyclopédie* a spice generally lacking in its more recent imitators, although PLINY its ancient predecessor had likewise indulged in satire and irony, — that « the most succinct of our articles of this sort will perhaps save our descendants years of research and volumes of dissertations », and that « a writing on our modes which is today thought frivolous will be regarded two thousand years from now as a learned and profound work on French costume, a work very instructive for men of letters, painters, and sculptors ». Whatever his publisher thought, DIDEROT did not conceive of l'*Encyclopédie* as a commercial undertaking nor as of the nature of ephemeral or popular literature, but as « *un dictionnaire universel et raisonné* », intended for the general and permanent instruction of mankind. It is as such that we shall accept it and examine it in the following pages. Our survey will be based primarily upon the original folio edition of 1751 and following, and our illustrations will be drawn chiefly from the earlier volumes in which the editors were freer in working out their plan and ideals without interference, and not from the last ten volumes which, after the suspension of the undertaking by the Parlement of Paris and the withdrawal of the scientist D'ALEMBERT from the co-editorship in 1759, were hurriedly and secretly completed by DIDEROT and then, without DIDEROT's knowledge, were much mutilated by the timid publisher, LEBRETON. Only in a few instances shall we include

articles from the supplementary volumes which were issued in 1776.

Our concern will be with the place of l'*Encyclopédie* in the history of science. This topic appears to have hitherto received little attention, either from the historians of the sciences or from students of the eve and background of the French Revolution. DIDEROT is noted individually in the history of medicine for his *Letters on the Blind* (2) and as a biologist has been represented as a forerunner of BICHAT, LAVOISIER, GALL and DARWIN (3). D'ALEMBERT is of course a well known name in the history of mathematical science and celestial mechanics. But when the Encyclopedists are viewed collectively, it is usually as materialistic « philosophers » who attacked the church and Bible and Christian religion, also « *les abus* » generally, and who agitated or paved the way for political and social reform (4). For JOHN MORLEY « philosophy » in the French eighteenth century sense of the word and as used in l'*Encyclopédie* was more or less identical with liberalism and the idea of progress. But I cannot interpret its meaning as quite in that sense. Not only does it, like the philosophy of ancient Greece, include all the sciences, natural, mathematical, and social; scientific research is its very essence. In its very title science came first : *Encyclopédie ou dictionnaire raisonné des sciences, des arts et des métiers par la société des gens de lettres.* When d'ALEMBERT in the *Discours préliminaire* states that « the Renaissance of letters... that memorable epoch..., began with erudition, continued with Belles-Lettres, and ended in philosophy » (5), he has in mind especially the scientific advance of the eighteenth century. DIDEROT, too, in the article « *Encyclopédie* », in comparing his own age with the seventeenth century, says, « Those sciences least common in the century past become more common from day to day », and speaks of the « general movement toward natural history, anatomy, chemistry, and experimental physics » (6). He even had confidence

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(2) See FIELDING H. GARRISSON, *An Introduction to the History of Medicine*, third edition, 1921, p. 360.

(3) F. PAITRE, DIDEROT *biologiste*, Lyon, 1904, 106 pages.

(4) See the work of JOHN MORLEY above-cited, pp. 4-5, and which will henceforth be referred to by the brief indication, MORLEY (1878).

(5) « ...la renaissance des Lettres ...cette époque mémorable.. On a commencé par l'Erudition, continué par les Belles-Lettres, et fini par la Philosophie ».

(6) « Les connoissances les moins communes sous le siècle passé le deviennent de jour en jour... mouvement général vers l'Histoire naturelle, l'Anatomie, la Chimie, et la Physique expérimentale.

that the expressions proper to those sciences would change the face of even popular speech, and that before another century passed a dictionary of the Age of Louis XIV or even of his own would not contain two-thirds of the words then in use. Alas! the technical vocabulary of the various sciences has increased too rapidly for any general assimilation of it into human speech, or, which is even more regretable, for any adequate absorption of scientific discovery and method into the general current of human thought.

Yet this last, too, was what Diderot and d'Alembert and their collaborators hoped and worked for, although they realized the need of two sets of workers, namely, researchers and winnowers (7). And it was in this connection that much of the philosophizing, more strictly called, of the two editors themselves came in. « Every science, every art has its metaphysics », says Diderot. « This side is always abstract, lofty, and difficult. Yet is should be the chief concern of a philosophic dictionary » (8), such as l'*Encyclopédie*. Similarly d'Alembert in treating the topic, « *Elements des sciences* », states that what is most needed is a metaphysics of propositions, which should be nothing more than a clear and precise exposition of the general and philosophic truths on which the principles of the science are founded. D'Alembert would perhaps agree with Diderot that the problem of making such an exposition was difficult, but he believed that the result should be easy to assimilate. « The simpler, easier, and, so to speak, more popular this metaphysics is, the more precious it is », for « truth is simple and should be treated as it is » (9). Yet d'Alembert had no patience with mere speculation or theorizing in physical science, and in both his articles on *Physique* and on experimental method strongly advised against « giving reasons for what escapes us » and against « that craze for explaining everything which Descartes introduced into physical science » (10). In both articles he gives the same illustration that, supposing the

(7) Described in Diderot's article *Encyclopédie*; the researchers would read but little, the others would thumb volumes day and night to separate what was worth receiving and conserving.

(8) « Toute science, tout art a sa métaphysique. Cette partie est toujours abstraite, élevée et difficile. Cependant ce doit être la principale d'un dictionnaire philosophique ».

(9) « Mais la vérité est simple et veut être traitée comme elle est. »

(10) Article *Experimental* ; « Cette fureur d'expliquer tout ce que Descartes a introduite dans la Physique ».

barometer rose before rain, physicists would explain the action by saying that the air had become heavier through being charged with vapors, and this would seem a reasonable explanation. But it is not satisfactory because the barometer falls instead of rising before rain. Or if it were the case that snow fell in summer and hail in winter, the explanation might be given that this was because in summer the heat of the air kept the particles from congealing completely, while in winter the cold air near the earth hardened them into hail-stones. This explanation would satisfy everyone, says D'ALEMBERT, and pass for demonstrative. Yet the fact which it explains is false. D'ALEMBERT also quotes with approval from MUSSCHENBROECK's *Essai de Physique* the assertion that « when one examines everything exactly, one finds that there are many more particular laws than general laws » (11). So much for some indication that, while somewhat more spirited and readable, not to say better written, than most modern encyclopedia articles and scientific monographs, l'*Encyclopédie* is not dominated by some facile philosophy but is permeated by a truly scientific spirit. And lest I seem unfair to Lord MORLEY, let me hasten to add that he was aware that DIDEROT, unlike VOLTAIRE and ROUSSEAU, had the idea of scientific method as well as the « rare faculty of true philosophical meditation », and that the social philosophy of *Encyclopédie* was founded in positive science (12). But Lord MORLEY was mainly interested in the social philosophy; we shall interest ourselves in the science.

Since, however, our investigation is an historical one, and since history may be regarded as one of the sciences — just as some of them are still classed as *Histoires* in l'*Encyclopédie*, while D'ALEMBERT closes his article on experimental method with the suggestion that in addition to the chair of experimental physical science recently established by the king at the University of Paris there should be three others in Ethics, Public Law, and History (13) — since this is the case, we may well commence with the attitude of l'*Encyclopédie* toward history and the history of science. « It is not enough for

(11) Article *Physique méchanique et corpusculaire*; « Quand on examine tout avec exactitude on trouve qu'il y a beaucoup plus de lois particulières que des lois générales ».

(12) See MORLEY (1878), pp. 8-9.

(13) Article *Experimental*; « trois objets qui appartiennent en un certain sens à la philosophie expérimentale prise dans toute son étendue ».

us », observes D'ALEMBERT in the *Discours préliminaire*, « to live with our contemporaries and to lord it over them. Moved by curiosity and self-love, and seeking with natural avidity to embrace at once past, present, and future, we wish at the same time to live with those who will follow us and to have lived with our predecessors. Hence the origin and the study of history » (14). Nor is it a science without high utility. « Philosophy, often powerless to correct abuses, can at least disentangle their origin (15). » DIDEROT for his part, in listing the qualifications of the ideal author and the ideal editor for an encyclopedia, stated some of the most essential traits in an historian. He should narrate events of his own time, « as if he were a thousand years off, and those of his native place, as if he were two thousand leagues away » (16). He should never be enthusiastic except for truth, virtue, and humanity. A great knowledge of bibliography is necessary or he will « repeatedly compose in mediocre style at much labor, time, and expense what others have done better » (17), and will go to great trouble to discover what is already known. Finally, « the exact citation of sources would be of great utility; one ought to make it a rule » (18).

The value of the history of science is recognized in the *Discours préliminaire*, where it is said that « the historical exposition of the order in which our sciences have followed one another will... enlighten us ourselves as to the way in which we should transmit these sciences

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(14) « Ce n'est pas assez pour nous de vivre avec nos contemporains et de les dominer. Animés par la curiosité et par l'amour propre, et cherchant par une avidité naturelle à embrasser à la fois le passé, le présent et l'avenir, nous désirons en même temps de vivre avec ceux qui nous suivront, et d'avoir vécu avec ceux qui nous ont précédés. De là l'origine et l'étude de l'Histoire. »

(15) « ...la philosophie souvent impuissante pour corriger les abus peut au moins en démêler la source. »

(16) Article *Encyclopédie*; « racontant les choses du moment où il vit comme s'il en étoit à mille ans, et celles de l'endroit qu'il hab te comme s'il en était à deux milles lieues ».

(17) « D'ailleurs faute d'une grande connoissance de la bibliographie, on est exposé sans cesse à composer médiocrement, avec beaucoup de peine, de temps, et de dépense, ce que d'autres ont supérieurement exécuté. On se tourmente pour découvrir des choses connues. »

(18) « La citation exacte des sources seroit d'une grande utilité : il faudroit s'en imposer la loi ».

to our readers » (19). And some of the particular articles, such as « Anatomie » (by HALLER, which appeared first in the supplementary volumes of 1776), « Chirurgie » and « Bibliothèque » contain very good or full historical summaries for the time when they were written. From them the historian of science might possibly get some valuable hints even today.

But an unfortunate philosophy of history and interpretation of the course of civilization tends to vitiate the historical outlook of l'*Encyclopédie* as a whole, and has similarly affected the study of the history of science since, although I do not know if this is a direct legacy from the French encyclopedia passed on through its various successors. First there is the notion that the history of science « is naturally bound up with that of a small number of great geniuses » (20), such as HIPPOCRATES in antiquity, ROGER BACON and ALBERTUS MAGNUS in the middle ages — who, though they lived in times when the profoundest ignorance prevailed, yet posessed a universality of knowledge in all the sciences « so uncommon in our enlightened age that they would pass even today for prodigies »(21)—, FRANCIS BACON, that great forerunner of the light, though « born in the bosom of blackest night », DESCARTES, who « changed the face of philosophy » (22), GALILEO, and especially LOCKE and NEWTON. As a matter of fact, of course, the works attributed to HIPPOCRATES were composed by a number of subsequent writers over a considerable lapse of time (23), which is perhaps a sufficient indication that great names are apt to have more credited to them than is their due. Second, there is far too emphatic and exaggerated generalization, as we have just incidentally noted, to the effect that the middle ages were « a long interval of ignorance », when for twelve centuries the chief works

(19) « L'exposition métaphysique de l'origine et de la liaison des Sciences nous a été d'une grande utilité pour en former l'Arbre encyclopédique; l'exposition historique de l'ordre dans lequel nos connoissances se sont succédées ne sera pas moins avantageuse pour nous éclairer nous-mêmes sur la manière dont nous devons transmettre ces connoissances à nos lecteurs. »

(20) *Discours préliminaire*; « D'ailleurs l'histoire des Sciences est naturellement liée à celle du petit nombre de grands génies... »

(21) Article *Cordelier* ; « Si peu connues dans notre siècle éclairé qu'ils passeroient encore aujourd'hui pour des prodiges. »

(22) *Discours préliminaire* for these two phrases.

(23) See TH. BECK, *Hippokrates Erkenntnisse*, and W SCHONACK, *Curae Hippocraticae*, Königsberg, 1908. S. HORNSTEIN, « Untersuchungen z. hippokrat. Korpus », in *Primitiae Czernovicienses*, 1911, pp. 54-82, and T. GOMPERZ, « Die hippokrat. Frage... » in *Philologus* 70, 213-41.

of the ancients were forgotten, when the church persecuted scientists, and when scholasticism « constituted all the pretended science of centuries of ignorance » (24).

The short article « Architecture » by BLONDEL is written from the academic Palladian standpoint which idolized the « simplicity, beauty, and proportion of ancient architecture » and insisted upon « propriety and correctness of design ». The article « Cathédrale » is even briefer, while full descriptions are given of military matters and industrial processes. It may be noted, however, that BLONDEL applied the term « Gothic » to the architecture of the early medieval period before CHARLEMAGNE, which he regarded as heavy and northern and the opposite extreme from the later medieval building, which went in his opinion to an excess of delicacy and profuse ornament under southern Saracen influence. BLONDEL evidently had a very imperfect knowledge of the history and dates of medieval architecture, and ascribed great influence on its course to HUGH CAPET and his son ROBERT.

As far as the disparagement of medieval science is concerned, some of the particular articles contain mentions of medieval scientists such as AL-HAZEN and WITELO (25) which are scarcely consistent with it. D'ALEMBERT concedes the discovery of the musical scale to GUIDO D'AREZZO (26) (c. 995-1050 A. D.), and has the grace to recognize that the origin of all our ideas in sensations had been held axiomatic by the scholastic philosophers long before LOCKE, but had been rejected during the Renaissance along with the rest of scholasticism (27). But such concessions and mentions of individuals affect not at all the general attitude of l'*Encyclopédie* towards antiquity, middle ages, and « Renaissance ». The difficulty is that the names of medieval scientists, when mentioned, have simply been taken from previous histories of the sciences; there is no evidence that their works had been looked into, much less read through, by the writers of the articles in l'*Encyclopédie*. It would have been better had d'ALEMBERT applied to the middle ages as well his *bon mot* concerning the ancients, « to whom we believe ourselves very superior in the sciences because we find it shorter and more

(24) *Discours préliminaire* ; « La Scholastique qui composoit toute la Science prétendue des siècles d'ignorance... »

(25) See article *Catoptrique*.

(26) See article *Gamut*.

(27) See *Discours préliminaire*.

agreeable to prefer ourselves to them than to read them » (28). Then he might have realized that it was not the ancients alone who « have not neglected *la physique expérimentale* as we ordinarily suppose », and might have avoided such errors as placing JOHN CAMPANUS of Novara in the eleventh century instead of the last half of the thirteenth, calling ADELARD OF BATH a monk, making GUIDO BONATI come from Friuli, dating PETER OF ABANO in 1320, and asserting that the only medieval version of the *Almagest* was a Jewish translation of an Arabic translation of a Syriac translation (29). But usually l'*Encyclopédie* makes no such recondite allusions as these to medieval science but contents itself with such legends as that of the condemnation of Bishop VIRGILIUS for believing in the Antipodes (30) or the

(28) See article *Expérimental*.

(29) For these statements see article *Astronomie*.

(30) See article *Antipode* and also the *Discours préliminaire* where d'ALEMBERT says, « comme le pape ZACHARIE avait condamné quelques siècles auparavant (i. e. before the time of GALILEO) un Evêque pour n'avoir pas pensé comme SAINT AUGUSTIN sur les Antipodes et pour avoir deviné leur existence six cents ans avant que CHRISTOPHE COLOMB les découvrit ». A writer in the *Mémoires de Trévoux*, 1708, had questioned if the papal letter was ever enforced against VIRGILIUS, but d'ALEMBERT will have none of this. He also rejects the suggestion that VIRGILIUS believed in the existence of two suns and two moons, and holds that the « another sun and moon » of the papal letter have reference to our sun and moon as seen from the other side of the globe.

The Latin text of the letter will be found in MIGNE, *Patrologia Latina*, vol. 89, where the portion concerning VIRGILIUS occurs in col. 946. After alluding to how VIRGILIUS has been stirring up trouble between BONIFACE and the duke of the Bavarians, the pope further instructs BONIFACE: « De perversa autem et iniqua doctrina eius, qui contra Deum et animam suam locutus est, si clarificatum fuerit ita eum confiteri, quod alius mundus, et alii homines sub terra sint, seu sol et luna, hunc habito consilio ab ecclesia pelle sacerdotii honore privatum » This may be translated: « As for his perverse and wicked doctrine which he has uttered against God's glory and his soul's safety, if he shall have unmistakably acknowledged a belief in another world and other men under the earth, or (another?) sun and moon (so placed?), hold a council, unfrock him, and expel him from the church ».

The Provost of Eton, in the *Cambridge Medieval History*, vol. III, pp. 512-13, doubts if VIRGILIUS was « an early martyr of science, persecuted and silenced by clerical obscurantists because of his belief in the Antipodes », and suggests that it is much more likely that a survival of pagan belief in « the underground people » of Celtic or Scandinavian fairy lore was what Pope ZACHARIAS had it in mind to condemn.

HERMAN VAN DER LINDEN, « *Virgile de Salzbourg, et les théories cosmographiques au VIII^e siècle* », Brussels, 1914, 27 pp., and the review thereof by

persecutions suffered by Friar BACON (31), whom JEBB's publication of the *Opus Maius* in 1733 had recently recalled to men's minds and whom d'ALEMBERT does characterize as « the monk (*sic*) BACON, too little known and too little read today » (32). HALLER's long account of the history of anatomy totally omits the middle ages and is valuable and very detailed for the period from VESALIUS on. And in general it is only for the sixteenth and seventeenth and early eighteenth centuries that l'*Encyclopédie* gives any accurate, interesting information anent scientific men and discoveries, some of whom are possibly now in their turn too forgotten.

We have already implied that l'*Encyclopédie* held the now much shattered and well nigh totally abandoned theory of the Renaissance in the closing fifteenth and sixteenth century, which it regarded as « one of those revolutions » which are necessary to free mankind from barbarism and which change the face of the earth. « The Greek Empire is destroyed, its ruin causes the little learning that still survived to flow back into Europe : the invention of printing, the protection of the MEDICIS and of FRANCIS I revived the mind of man; and light everywhere had new birth » (33). What an improbable,

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S. GÜNTHER in *Mitteilungen zur Geschichte der Medizin und der Naturwissenschaften*, XIV (1915), 23-24, review the previous literature anent VIRGILIUS from AVENTINUS (JOHANNES THURMAYR, 1477-1534), the father of Bavarian history, down through KEPLER, DESCARTES, and others to the present. They also recognize that belief in the Antipodes was not so exceptional at that time, and that, whatever other outcome the letter of ZACHARIAS may have had, it did not prevent VIRGILIUS from becoming a bishop in 767 under the later pope, PAUL I, or from being canonized in 1233 by GREGORY IX.

(31) See article *Cordelier* : « Le frère BACON, célèbre par les persécutions qu'il essuya dans son ordre et par les découvertes qu'il fit dans un siècle de ténèbres. »

(32) See article *Expérimental* : « Le moine BACON, trop peu connu et trop peu lu aujourd'hui... dans le sein de la plus profonde ignorance il sut par la force de son génie s'élever au-dessus de son siècle. »

(33) « *Discours préliminaire* » ; after a few such phrases as « en sortant d'un long intervalle d'ignorance » and « l'état d'esclavage où presque toute l'Europe étoit plongée » with reference to the medieval period, d'ALEMBERT proceeds : « Aussi fallut-il au genre humain pour sortir de la barbarie une de ces révolutions qui font prendre à la terre une face nouvelle : l'Empire Grec est détruit, sa ruine fait refluer en Europe le peu de connoissances qui restoient encore au monde : l'invention de l'Imprimerie, la protection de MEDICIS et de FRANÇOIS I animent les esprits ; et la lumière renait de toutes parts. »

insufficient, irrelevant, rhetorical set of explanations! D'ALEMBERT would have been ashamed to approach a problem in physics in this manner. Yet such explanations of the « Renaissance » satisfied most writers and readers for over a century longer. But D'ALEMBERT was at least keen enough to see that the humanists had the defects of servile imitation of the ancients and too great self-complacency, and that they too narrowly devoted themselves to literary erudition, to the exclusion of scientific research and political and social reform.

The philosophy of history, then, is a weak point of l'*Encyclopédie*, not in harmony with the scientific spirit evidenced elsewhere in it, lending justification to the charge of shallow thinking and too great trust in « reason » which has been made against the French « philosophers ». Sometimes, however, D'ALEMBERT makes a happy observation, as when he says that « the infancy of the sciences is long, or better, eternal » (34). And the theory of revolutions expressed so frequently in l'*Encyclopédie* is interesting both as a sort of survival of the astrological doctrine of revolutions, and in view of the approaching French Revolution at which the encyclopedists more than once hint darkly (35).

Along with this faulty philosophy of history goes an uncritical attitude in historical matters generally. Indeed, the fact that at first

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(34) Article *Experimental* : « et l'enfance des Sciences est longue, ou, pour mieux dire, éternelle. »

(35) D'ALEMBERT touched on the point in the « *Discours préliminaire* » as noted in note 33 above; DIDEROT speaks of such revolutions in the article « *Divination* » and again in the article « *Encyclopédie* », where he says : « Le moment le plus glorieux pour un ouvrage de cette nature, ce seroit celui qui succéderoit immédiatement à quelque grande révolution; qui auroit suspendu les progrès des Sciences, interrompu les travaux des Arts, et replongé dans les ténèbres une portion de notre hémisphere. Quelle reconnoissance la génération qui viendroit après des tems de trouble ne porteroit-elle pas aux hommes qui les auroient redoutés de loin; et qui en auroient prévenu le ravage, en mettant à l'abri les connoissances des siècles passés ? » What honors, he adds, will they not heap on the authors who suffered for it, what indignation on their enemies; what glory 'twill lend to the Monarch or Minister under whom it appeared and to the Great who favored it ! D'ALEMBERT, too, returned to the subject again in the article « *Experimental* » where he said that, once the foundations of a revolution were laid, it would almost always come to a head in the generation following; « seldom sooner because the obstacles to it perish rather than yield; seldom later than that because when once the barriers are broken the human spirit often goes faster than itself intends, until it meets a new obstacle that

« all the articles in ancient and modern history », as well as « all the articles concerning poetry, eloquence, and literature in general » (36), were the work of MALLET (1713-1755), a doctor of theology and professor at Paris, who further was responsible for the thelogical articles, does not augur well for the independent treatment of history in l'*Encyclopédie*. However, he does not seem to have had much to do either with its philosophy of history or its treatment of the history of science.

At first it amazes the reader that a work supposed to represent a revolt against the Christian church should unquestioningly accept the chronology of the Old Testament as the opening chapter of human history, and begin its historical introduction concerning almost any topic with an account of the belief or practice of the ancient Hebrews in this regard. I fail to detect any satire or mental reservation in such passages; they seem the regular course of procedure and quite matter-of-fact. It must be kept in mind that scientific excavation and archaeology had not yet disclosed the early history of man; that Africa, Australasia, and most of America were still unknown continents, while countries like Russia and Japan were outside the pale of civilized intercourse; that none of the ancient oriental languages had been deciphered, so that a scholar could seriously argue that the arts of divination had arisen from the ancient Egyptians forgetting the meaning of their hieroglyphic symbols and attaching themselves to the mere letters (37). Sanskrit, too, was as yet unknown to European scholars, so that the chief accounts of the early history of man were the Old Testament, Homeric poems, and legends of the seven early kings of Rome. The encyclopedists accepted the last of these three as historic fact, and might equally well accept the first. When NEWTON had gravely discussed the duration of the world on the basis of the chronological implications

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forces it to rest for a long period. » (« Car quand les fondemens d'une révolution sont une fois jettés, c'est presque toûjours dans la génération suivante que la révolution s'achêve; rarement en-deçà parce que les obstacles périssent plûtôt que de céder; rarement au-delà parce que les barrieres une fois franchies l'esprit humain va souvent plus vîte qu'il ne veut lui-même, jusqu'à ce qu'il rencontre un nouvel obstacle qui l'oblige de se reposer pour long-tems. »)

(36) From the « *Discours préliminaire* » which adds, « On voit par le détail où nous venons d'entrer combien M. l'Abbé MALLET, par la variété de ses connoissances et de ses talens, a été utile à ce grand Ouvrage, et combien l'Encyclopédie lui a d'obligation. Elle ne pouvoit lui en trop avoir. »

(37) See the article *Divination*.

of *The Book of Genesis* and had come to the conclusion that the Argonautic expedition would have to be dated in 900 rather than 1400 B. C. (38), is it surprising that D'ALEMBERT, though rejecting as ridiculous the story of the Babylonians having made astronomical observations for 470,000 years, should incline to accept PORPHYRY's assertion that when ALEXANDER THE GREAT took Babylon these observations had been in process for some 1903 years, which would fix the origin of them 115 years after the deluge and fifteen years after the erection of the tower of Babel in a plain where no mountains cut off the view of the stars? (39) Yet on such a topic as the Concordat of 1516 and its relation to the Pragmatic Sanction of Bourges l'*Encyclopédie* offers an admirably clear and precise account.

Indeed in general there is less either of open attack or covert satire against theology and religion than I had expected in l'*Encyclopédie*, and also, perhaps, less than many of its readers were hoping for, as would appear to have been the case from the letters of VOLTAIRE to D'ALEMBERT and the letter of D'ALEMBERT to VOLTAIRE quoted by Lord MORLEY (40). D'ALEMBERT himself, rather than DIDEROT, seems to have been the one most ready to break a lance with orthodoxy or the clergy (41), and sometimes apparently went outside his proper scientific field to write articles which would give him that opportunity, for instance, those on Geneva, the Jewish Cabbala, *Forme substantielle*, *Formulaire*, and Fornication. In dealing with the last topic, as might have been expected, he was ably aided and abetted by VOLTAIRE. The article « *Formulaire* » administers a stinging rebuke to religious quarrels in general and that connected with the Jansenists in particular.

I have never been able to see that the deluge theory in geology was especially the work of the church. Certainly it was not a product of the middle ages, — when there seems to have been rather less respect for the literal sense of the Bible than there was after the invention of printing and the Protestant Revolt (42) — but, as the

(38) Sir ISAAC NEWTON, *The Chronology of Ancient Kingdoms amended ; to which is prefix'd a short chronicle from the first memory of things in Europe, to the Conquest of Persia by* ALEXANDER THE GREAT, London, 1728.

(39) See article *Astronomie*.

(40) MORLEY (1878), I, 137-139.

(41) Yet he abandoned the enterprise halfway, while DIDEROT put it through.

(42) For medieval attempts to explain away the literal sense of the Bible in behalf of the scientific attitude see my *History of Magic and Experimental Science*, 1923, II, 58, 175, 197, 414, 464.

article on Fossils in l'*Encyclopédie* states, began to develop in the sixteenth century. Even the letter of the Bible was not here in question, for, as our article further states, *The Book of Genesis* does not say that the fossil fauna and flora buried in the earth or the shells and marine bodies found at great heights above sea level were deposited by NOAH's flood. The theory presumably developed because that flood, like King NUMA or ROMULUS, often suggested itself to the minds of the scientists of that supposedly more enlightened age. If any of them actually desisted from another explanation from fear of religious persecution, one suspects that they must have been under a misapprehension or troubled by their own morbid consciences. Certainly the writer in l'*Encyclopédie* makes no bones of rejecting the deluge as an explanation of the present location of fossils (42*a*).

On the whole, Christian theology and institutions seem to have been minimized by brevity of treatment and reduction of the amount of space devoted to them rather than by devoting unfavorable attention to them. Thus the writer of the article on Faith, l'Abbé MORELLET of the Sorbonne, whose contributions Lord MORLEY noted as « the chief examples... of a distinctively and deliberately historic treatment of religion » (43), apologizes for the extreme length of his article (44). But it is shorter than that on Fountains or *Forges* or Furnaces, while the article on Fundamentals of Faith occupies less than a page. The success of l'*Encyclopédie*, despite its faults, was ascribed by DIDEROT to the great number of new things in it which could not be found elsewhere (45). And where l'*Encyclopédie* has perhaps had the most lasting and distant effect upon the Christian religion is that people today refer to an encyclopedia rather than read the Bible.

The new matter which crowded out or reduced the relative importance of theological, scholastic, and classical interests was in large measure the full discussion of the mechanical arts, industrial and agricultural processes, and especially machines. And this was the especial department of DIDEROT, himself the son of a cutler. Thus the article on the stocking knitting frame (46) and its 2,500 parts

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(42*a*) See MORNET, *Les sciences de la nature en France au XVIII^e siècle*, 1911, pp. 18-23, for some even more fantastic theories of the origin of fossils than that of the deluge.

(43) MORLEY (1878), I, 132.

(44) It covers 16 folio pages in the first edition while the articles on fountains, forges, and furnaces cover respectively 21, 33, and 46 pages.

(45) See article *Encyclopédie*.

(46) See article *Bas*.

was over ten times as long as the article on cathedrals. At that time this frame was « one of the most complicated and important machines that we have ». It is indeed remarkable that DIDEROT should have laid so much stress upon machinery at a time when it was so little developed, and we must regard him as a prophet of the industrial revolution as well as of the French Revolution. The mention of JETHRO TULL in the article on agriculture shows l'*Encyclopédie* in touch also with recent progress in that direction. The article *Bateau*, on the other hand, is very brief, and in general the problem of transportation does not seem to have received great attention. The utilitarian argument advanced in the *Discours préliminaire* on behalf of the mechanical as against the liberal arts would hardly seem to cover the generous space accorded to the art of war. And it is with regret that one finds the article *Machine* occupied more with the infernal machine than any other, and that one further finds its introduction into warfare ascribed not to cruel tyrants but to the Dutch against ALEXANDER OF PARMA and the English against the coast towns of France.

DIDEROT found difficulty in learning about the arts from artisans, who wished to keep their profitable processes secret or feared governmental interference and taxation and often told him « the most ridiculous falsehoods » (47). He also was interested in the history of the mechanical arts and felt the need of an account of their origin, but feared that little historical material would be available and that it would have to be largely hypothetical. D'ALEMBERT, too, in the *Discours préliminaire* asked why those who had developed the mechanical clock and watches should not be as esteemed as those who had successively perfected algebra. In his account of whale-fishing (48) DIDEROT goes into its past history, mentioning the contention of some that sailors from Cap Breton near Bayonne, in following the whales far to sea to discover their retreats, discovered Newfoundland and Canada a century before COLUMBUS, while others held that the first voyage to America for whales was made in 1504 by the Basques.

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(47) See article *Encyclopédie*.

(48) Appended to the article *Baleine*. See J. T. JENKINS, *A History of Whale Fisheries*, 1921, pp. 59-66, for further evidence and bibliography concerning Basque whaling at Newfoundland before COLUMBUS But he does not mention Cap Breton or *l'Encyclopédie*.

The need of science in the arts was strongly felt by DIDEROT. A well trained naturalist would « recognize at a glance the substances employed by artisans of which they commonly make so much mystery ». Their absurd lies would not impose on a chemist for a moment. A physicist would see the « explanation of no end of phenomena at which the workingmen remain astonished all their lives » (49). So we may credit l'*Encyclopédie* with having done not a little to encourage the development of applied science.

But we now turn to the science more strictly speaking of l'*Encyclopédie* with the particular purpose of examining how far its scientific articles have advanced from the conceptions current in ancient and medival science to those of recent years, and what their attitude is to the occult science, the magic, and the superstition of which there were so many traces in ancient and medieval science. On the whole it may be said that l'*Encyclopédie* shows us science fairly thoroughly purged of magic, and that its opposition of science against superstition is more frequent and manifest than that of deism against Christianity. But it is further to be observed that neither is much light thrown on the problem how these magical beliefs and practices came to be abandoned, nor are we usually given any more satisfactory or scientific arguments against them than had been adduced in the past. Such superstitious notions are commonly simply dismissed with a stock formula of condemnation to the effect that in this present enlightened century it is unnecessary to demonstrate their chimaerical character (50). This airy waving aside of past tradition and this confidence in contemporary enlightenment does not, however, entirely satisfy us, especially when we read in l'*Encyclopédie* itself that as recent and distinguished a scientist as BOYLE had believed that some amulets were effective, because he had

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(49) « *Encyclopédie* »; Naturaliste, il connoîtra d'un coup d'œil les substances que les Artistes employent et dont ils font communément tant de mystère... La Physique lui rendra raison d'une infinité de phénomènes dont les ouvriers demeurent étonnés toute leur vie. »

(50) Thus in the article, « Abracadabra », we read, « Quant aux vertus attribuées à cette amulette, le siècle où nous vivons est trop éclairé pour qu'il soit nécessaire d'avertir que tout cela est une chimère »; in « Almanach, » we read, « Notre siècle est trop éclairé pour qu'une pareille défense soit nécessaire; et quoique nous voyons encore plusieurs almanachs remplis de ces sortes de prédictions, à peine le plus bas peuple y ajoute-t-il quelque foi. » See also the articles on Asp, Ascendant, Astrologer, Catalepsy, Comet, Configuration, *Coq*, for the same attitude or a silent but complete omission of former superstitions.

finally succeeded in checking a nosebleed when other remedies failed by the method of applying some of a powdered human skull on the skin, while VAN HELMONT had cured patients of the plague by troches of pulverized toads worn as amulets (51). As for philtres, after citing VAN HELMONT, HARTMANN and LANGIUS in their favor, l'*Encyclopédie* concludes that while there may be ones which drive persons mad or cause loss of memory, it is difficult to believe that there are any which inspire love for one particular person rather than for another (52).

Most of the articles on specific magic arts were written by the aforesaid general utility man, MALLET, perhaps being considered to fall under the caption of Theology, which was one of his departments. They are usually disappointing, displaying little originality or breadth of knowledge and being largely based upon DELRIO's *Disquisition on the Magic Arts*. The article on *Magie* itself, however, forms somewhat of an exception, belittling the importance of natural and supernatural (or diabolical) magic, although pronouncing both natural and divine magic unobjectionable. Greek fire is mentioned as an example of the natural magic of the ancients, who are regarded as more advanced in this field than the moderns. But already we find magic regarded as to-day as especially the affair of savage and barbarous peoples (53). It is briefly defined as « an occult science or art which trains one to do things which seem beyond human power » (54). Another exceptional article is that on divination, written by DIDEROT himself, but it is less notable for its discussion of its proper subject than for its conclusion urging the writer's contemporaries to stand out fearlessly against error as CICERO did against divination and the early Christian martyrs did against paganism. However, it also enters on speculations as to the origin of divination under the stimulus of CONDILLAC's *Philosophic Conjectures on the Origin and Progress of Divination*,

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(51) See article *Amulette*. MORNET, *Les sciences de la nature en France au XVIII^e siècle*, chapter 2, « La lutte contre le merveilleux, » gives examples of the continued belief in the eighteenth century in « marvels of nature », such as a talking dog, the fatal glance of the basilisk, and sirens.

(52) See article *Philtre*.

(53) « *Magie* »; « Comme c'est une science ténébreuse, elle est sur son trône dans les pays où règnent la barbarie et la grossièreté. Les Lapons et en général les peuples sauvages cultivent la magie et en font grand cas. »

(54) *Ibid.*, « ...science ou art occulte qui apprend à faire des choses qui paroissent au-dessus du pouvoir humain... »

and, besides the usual division of artificial from natural divination, distinguishes from chimaerical divination the experimental variety drawn from natural causes — such as, presumably, weather prediction. The divining rod is handled rather tenderly in the article *Baguette*. Physiognomy, however, is called a pretended art, and the arguments of BUFFON against it are cited, which reduce to the contention that the soul has no connection with the liniaments of the face or the figure of the body — a line of argument which would hardly by adopted by a materialistic philosophy such is sometimes thought to have characterized l'*Encyclopédie*. Similarly the chief argument against judicial astrology is the favorite patristic and theological one of human free will and morality (55). All the other arguments are stale and stock, nearly as old as the art of astrology itself, and directed chiefly if not exclusively against horoscope-casting. The attack upon astrology in VOLTAIRE's *Philosophical Dictionary* is even less considerable and made up partly of pleasantries.

MALLET holds fast with BOYLE to natural astrology or astrometeorology, affirming that humidity, heat and cold, and the like are dependent on the revolutions, movements, and positions of the other planets as well as sun and moon; that each planet has its own light, modifying the reflected rays of the sun so that the rays are endowed with a specific power of the planet's own which varies with that planet's aspects in reference to the sun and distance from the sun, and so exerts an energetic virtue on sublunar beings. Astrology thus seems to have lost nothing as a result of the change from geocentric to heliocentric hypothesis. Likewise the preliminary *Explication du système des connoissances humaines*, besides physical astronomy, recognizes as distinct from « the chimaera of judicial astrology » that science of the influences of the stars known as physical astrology. When therefore d'ALEMBERT, writing the article *Astrologue*, says that, while formerly the greatest men seem to have believed in astrology, now the name of astrologer has become so ridiculous « that even the lower classes put but little faith in the predictions of our almanachs », he perhaps means to censure only the prediction of human fate. However, his articles *Ascendant* and *Configuration* are also unfavorable and in the articles *Fœtus* and *Generation* no reference is made to the influence of the planets on the process of the formation of the child in the womb. Here again, as in the case of religion and the

(55) « *Astronomie* » was treated by d'ALEMBERT, but « *Astrologie* » by MALLET, except that d'ALEMBERT added a bit about the attitude of TACITUS to the subject.

mechanical arts, it is perhaps a case of the attention being diverted to new things, for the space formerly occupied by astrological doctrine is now filled with an account of observations through the microscope. MALLET's article *Arithmancie* warns the reader that the passage in *The Book of Revelation* concerning the number of the beast should not be confused with this divination by means of numbers nor cited to justify it, — possibly a mischievous dig at the Bible.

DIDEROT's distinction between chimaerical divination and the experimental variety drawn from natural causes reminds one of the close connection between magic and experimental books in the middle ages. In D'ALEMBERT's article on experimental method he makes a distinction between observation or even ordinary human experience and the experimental method. To the last the ancients did not apply themselves to any great extent, contenting themselves with reading the book of nature, but very assiduously and with better eyes than moderns think, but cultivating experiment proper only in the useful arts and not to satisfy, like us, a purely philosophical (or scientific) curiosity. Experimental method seeks to penetrate more deeply into nature's secrets, to create somehow by different combinations of bodies new phenomena to study : in fine, it does not merely listen to nature but questions and heckles her (*la presse*). One might call it occult physics, provided the word « occult » be understood in a more philosophic (scientific) and true sense than by certain modern physicians (or, physicists) and restricted to knowledge of concealed facts, not applied to the romance of supposed facts. Here again the association of the experimental with the occult, but passing from the magical to the scientific realm! And while we have heard D'ALEMBERT advise against « giving reasons for what escapes us », he would only encourage « that spirit of conjecture which, at once timid and enlightened, leads sometimes to discoveries », provided it remains conjectural until real discovery is assured.

D'ALEMBERT's use of the word « occult » suggests the question, how far does the belief in occult virtues survive in l'*Encyclopédie*. We have already touched somewhat on the point in speaking of amulets and philtres. The marvelous properties that had been once attributed to gems are totally discredited and even the medicinal properties are usually omitted in the articles on the stones themselves (56). As M. DE VANDERNESSE remarks in his article on the

(56) See, for instance, the articles on the agate, amethyst, alectory, and bezoard.

agate, « Great virtues are attributed to the agate the same as to other precious stones; but they are all imaginary ». Even the bezoard is discussed at some length without mention of the virtues ascribed to it. Chemistry is described in the introductory *Explication du système des connoissances humaines* as artificial research for the interior and occult properties of natural bodies, but here the meaning is evidently of the scientific sort desired by D'ALEMBERT. However, it is also stated that « chemistry has given birth to alchemy and natural magic ». And MAMOUIN, writing on alchemy, complains that « chemistry makes ungrateful use of the advantages she has received from alchemy; alchemy is maltreated in most chemical books »; and he distinguishes between the true alchemist and the charlatan. VENEL, in a long article on *Chymie* which has at least this much in common with the writings of the alchemists that it is muddy to the uninitiated, regards BOYLE as a mere physicist and longs for chemistry to come into its own and not be tied down by physics or subordinated to physics as the more general science.

L'*Encyclopédie* displays not a little scepticism on the subject of *materia medica*. The article on the cat warns us that while most authors of works of *materia medica* have recommended the use of different parts of the animal for this and that, not one of them has confirmed it by his own experience, and that it doubts « *ces prétentions de livre en livre* ». It adds, however, perhaps for our amusement, that one author enjoins that the sex of the cat employed be the same as the sex of the patient. The article on the dog, however, appears to be more credulous as to its medicinal properties. The oldwife's remedy of opening a little dog and applying it all hot to the head is characterized as « perhaps too neglected today » (57). Dog fat is recommended. The excrement of the dog is said to be used by apothecaries under the name *album graecum*, and in this case we encounter the old familiar suggestion that the dog be fed on bones. The recipe of stewing three new-born puppies in olive oil is given, but the comment is added that the only value of the puppies is their fat; that is, the attendant circumstances are really useless. The writer on the cabbage states that most of the medicinal properties ascribed to it by the ancients are today doubted, and that he is inclined to go still further and rank it only as a food and not

(57) « Ce remède de bonne femme, peut être trop négligé aujourd'hui ainsi que la plupart des applications extérieures, a produit quelquefois de bons effets... »

as a medicine at all. On the other hand, the article *Cigogne* lists the use of various parts of the stork against poisons and the pest, for eye-troubles and other complaints. The Chevalier DE JAUCOURT rejects all that PLINY and PAUL OF AEGINA, VAN HELMONT and MULLER have said concerning the virtues of ear-wax as wretched stuff. « Let's tell the truth : that humour of the glands which appears from its consistency and bitterness a compound of wax and oil may have some slight cleansing, abstergent, and detersive quality » (58), but there are many better remedies of that sort. On the subject of poisons the contributor DAUBENTON, BUFFON's « faithful lieutenant and squire at arms » (59), was quite sceptical, doubting, for instance, from his own experience and that of others who had worked with antimony without experiencing bad effects, if its vapors were poisonous, as most chemists and PARACELSUS held (60), and also if spiders at least in France were poisonous except for inflaming the skin. VANDERNESSE added to this the comment, « The medical man treats the poison and sting of the spider a little more seriously than the naturalist », but he declares that experience does not support the belief that a spider's web is a specific against intermittent fever (61).

Yet the naturalist affirmed that little spiders grew at the same rapid rate whether they ate or not. According to his account they grow almost as you watch them. If they can catch a fly, they eat it, but they sometimes go for a day or two or even longer without being seen to take nourishment, « yet they enlarge always at the same rate, and their increase is so rapid that each day they more than double in size » (62). We are assured, however, that the chameleon does not live on air (63). It is a little discouraging to note that l'*Encyclopédie* still finds it necessary to enter into full and explicit denial of the old tale of the beaver's biting off his testicles to save himself from the hunters (64), when it had already repeatedly been

(58) « Parlons vrai : cette humeur des glandes qui paroît par sa consistance et son amertume un composé de cire et d'huile peut avoir quelque médiocre qualité savonneuse abstergente détensive... »

(59) MORLEY (1878), I, 129-130.

(60) See article *Antimoine*.

(61) See article *Araignée*.

(62) *Ibid.*, « cependant elles grossissent toujours également, et leur accroissement est si prompt qu'il va chaque jour jour à plus du double de leur grandeur. »

(63) See article *Caméléon*.

(64) See article *Castor*.

shown false both in antiquity and the middle ages. And we find the article *Chameau* still citing SOLINUS to the effect that the camel has but one hump, and ARISTOTLE and PLINY to the effect that it has two humps and the dromedary only one. The article on the bat states that most authors have taken it for a bird, but that it is a quadruped (65). The long article on the carp and its anatomy is GALEN-like in regarding the marvelous structure of its parts as evidence of « the hand of the sovereign Artist ». Similarly the article *Coquillage* urges the study of such species in many different localities in order to gain « a new idea of nature's resources and of the sovereign Intelligence who is their Author » (66). The article on the brain gives the opinions of different authorities as to what part of the brain the soul resides in, and discusses whether the brain is necessary to life, citing the case of three children who were born without any, and one who was born without a head (67). Thus the marvels of animals have not entirely disappeared from l'*Encyclopédie*. One the other hand, of course, positive progress was being made and registered. For example, the article on coral (68) refers to the discovery of the coral insects in 1725 by PEYSONNEL on the Barbary coast and to his subsequent investigation of similar species of so-called marine plants (madrepores, lithophytes, and sponges) at Guadeloupe, whence in 1753 he sent BUFFON and DAUBENTON a work in manuscript which they hoped soon to publish. In the meantime DAUBENTON quotes from DONATI'S *Della storia naturale marina dell' Adriatico saggio*, published at Venice in 1750.

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(65) See article *Chauve-Souris*.

(66) « Nous prendrons une nouvelle idée des ressources de la Nature et de la souveraine intelligence qui en est l'auteur. » BOURGUET, *Catalogue raisonné des Coquilles*, 1736, was, MORNET (1911), p. 7, notes, a very learned compilation found in many libraries.

(67) See article *Cerveau*.

(68) Sir JOHN HILL, in his translation of THEOPHRASTUS' History of Stones (London, 1746), with many learned notes, still agreed with THEOPHRASTUS that coral was a vegetable growing in the sea; « it were easy to overthrow all that has been advanced as to its belonging to animals or being of the mineral kingdom » He also was behind *l'Encyclopédie* in accepting the deluge theory to account for fossils.

S. GÜNTHER, « Die Korallenbauten als Objekt wissenschaftlicher Forschung in der Zeit vor DARWIN. » *Bavarian Sitzb., Math.-Phys. Kl.* (1910), 14, states that SHAW, FORSKAL, and LINNAEUS agreed with PEYSONNEL as to the animal nature of coral, but that RÉAUMUR, STATIUS, MÜLLER, and KLEIN opposed this view.

The old problem of animal psychology is touched on by D'ALEMBERT in the article *Forme substantielle*. DESCARTES had held that animals do not suffer pain but only seem to do so. This D'ALEMBERT rejects but cannot explain why other animals who have similar organs and sometimes keener sensations than man should not have attained the power of reflection and abstract ideas. He comes to the somewhat lame conclusion that we must be content to believe that beasts suffer, that our souls are spiritual and immortal, that God is always wise and just, and to remain in ignorance of the rest. The article on physiology by HALLER retains the old classification of the actions and functions of the human body as vital or natural or animal, but holds that everything which is purely corporal in man can be fully explained by laws of mechanics and physics, and that « the definition of the circle is no clearer in geometry than the light that often guides a wise (medical) practitioner » (69). « As for the mutual intercourse of soul and body it is not only the most inconceivable thing in the world but even the most useless to the medical man » (70). A cure is a change made in the human body by the action of other bodies, so the physician should attend solely to the body.

We are thus brought back again to the subject of medicine. The encyclopedists were none too well satisfied with the medical learning or practice of their time. In praising the Hippocratic collection in his article upon experimental method D'ALEMBERT said : « In place of those systems, if not murderous, at least ridiculous, to which modern medicine has given birth only to reject them shortly, one finds facts well envisaged and well put together; one sees a system of observations which still serves today and which apparently always will serve as a basis for the healing art ». Similarly the Chevalier DE JAUCOURT affirmed that no one had described cholera better than CAELIUS AURELIANUS and ARETAEUS or indicated a better treatment for it; that moderns added nothing, but rather too often deviated from the almost forgotten practice of the ancients in this disease (71). GALEN was perhaps mentally associated too closely with the despised middle ages to receive such unqualified praise. However, the article

(69) « *Physiologie* »; « La définition du cercle n'est pas plus claire en Géométrie que les lumières qui guident souvent un savant practicien. »

(70) *Ibid.*, « Quant au commerce mutuel de l'ame et du corps c'est non seulement la chose du monde la plus inconcevable mais même la plus inutile au médecin. »

(71) See article *Choléra*.

Galenisme admits his personal greatness and sketches some of his life, but holds that he subjected medicine too much to general ideas and made it too easy — which explains why everybody followed him; that he made too much of the four qualities; and that his association of critical days with the stars or moon was erroneous. The article *Complexion* (in the sense of state of health or natural habitude of the body) rather apologizes for rehearsing the ancient fourfold division into temperaments : sanguine, connected with air, and hot and wet; flegmatic, connected with water, and cold and wet; choleric or bilious, connected with fire, and hot and dry; melancholy, connected with earth, and cold and dry. « Not much attention is any longer paid to such divisions; experience has proved an eye-opener on many prejudices and opinions, of which it is nevertheless necessary to give an account, so that each person can accept or disregard them as he judges fit » (72). Yet we find VANDERNESSE arguing that a sea bath is the best remedy for mania because the qualities of fluidity, humidity, and heaviness are increased by the salt in the water, while the terror of the patient may excite a reaction which will restore his deranged imagination. And several experiences seem to show that a cold ducking is good for frenzy (73). Bleeding still remained a favorite medical procedure. The article on Phlebotomy enters upon arguments in justification of it that would put a scholastic to blush. When the blood is too viscous and slow-moving, blood-letting will enliven it and make it hotter; but in a plethora resulting from too great a quantity of spirituous aliment — the secretion of spirit goes on in the brain — or a diminution of transpiration, phlebotomy will make the blood circulate more slowly and refresh it. In the former case blood-letting by lessening the resistance in the blood-vessels will increase their contractive power; in the latter case it will have the opposite effect, since the heart and arteries will no longer contract so often and so vigourously as before. VENEL's article on climate disputes the medical theory that one ought to drink a great deal of water in hot climates in order to repair the dried-up blood, holding that to drink undiluted water there is very harmful, and that acids,

(72) « On ne fait plus guère d'attention à toutes ces sortes de divisions : l'expérience a ouvert les yeux sur bien des préjugés ou des opinions, dont il faut cependant rendre compte, afin que chacun puisse en faire usage ou le mépris qu'il jugera à-propos. »

(73) See the article *Bain*, medical section.

spices, wines and spirituous liquors are much better and are more salutary in hot than in cold countries, although admitting that the *abuse* of strong liquors is more injurious in a hot climate. The article on wine repeats this contention, adducing the habits of the peasants of the *Midi*, and is also inclined to agree with HIPPOCRATES, DIOSCORIDES, AVICENNA, and the Stoics that it may be a good thing to get drunk occasionally.

A chief reason for the scepticism shown in l'*Encyclopédie* on the subject of *materia medica* was the advance being made in chemical knowledge. This was especially destructive to the elaborate compound medicines recommended in pharmacopeias, since it could be shown that some at least of their ingredients had properties which would nullify one another. Pharmaceutical chemistry for a considerable period before l'*Encyclopédie* had been reducing the vast number and reforming the constituents of these confections and electuaries, but had not gone far enough to suit VENEL (74). He says that of about thirty in the *Universal Pharmacopeia* of NICOLAS LÉMERY (1697) only three are now in usage in France, which three VENEL proceeds to describe and criticize. The *confection d'hyacinthe* as modified by LÉMERY contained 1 and 1/2 ounces of prepared hyacinth, although powdered sapphires and emeralds were now omitted; one ounce each of red coral, *terra sigillata*, and « *santal citrin* »; six gross of raspings of deer's horn; three gross each of bone from a deer's heart, root of tormentil, white dittany, dittany of Crete, saffron, myrrh, red roses, sorrel seeds, lemon, purslain; four scruples of crabs' eyes, and of the skins of lemons and sour oranges; ten grains each of ambergris and musk; one ounce of sirup of kermes; and three pounds — which VENEL criticizes as far too much — of sirup of carnation pinks. Another compound comes down, somewhat altered, from MESUË, and « old theriac » is still in use and not unfavorably regarded by l'*Encyclopédie* itself. Coral was employed as an ingredient in many other troches, pills, powders, opiates, and tablets than the confections above mentioned (75).

Willy-nilly, then, the encyclopedists still retained many conceptions of past science — and even of the medieval past which they scorned — which have since been abandoned. Their very chart of the departments of human knowledge (76) has a medieval character with

(74) See his articles, *Confection* and *Electuaire*.

(75) See the article *Corail*.

(76) « Système figuré des connoissances humaines, » found at the beginning of the first volume after the « Discours préliminaire ».

its optic, dioptic, and catoptric, its classified prodigies and monstrosities of nature, its science of God and science of spirits, its pneumatology or science of the soul, its mention of falconry under zoology. The conception of four elements was far from having been completely abandoned, as we have seen, and the phlogistic theory of the principle of fire was, of course, still in force (77). The article, *Froid (Economie animale)*, opens with the statement that the element fire is found more or less in all bodies.

Inasmuch as the phlogiston theory continued through the century, and the nature of heat was not clearly understood until the middle of the nineteenth century, it is interesting to note the discussion of heat and cold in l'*Encyclopédie*. VENEL's article, *Froid* (*Physique*), after giving and criticizing the views of ancient philosophers, says that most modern natural philosophers (*physiciens*) hold that in general cold is only less heat, and that the thermometer marks equally degrees of heat and cold. The article, *Chaleur*, states that some call heat a quality; others, a substance; others, a mechanical affection. BACON, BOYLE, and NEWTON are cited as conceiving of heat not as a property originally inherent, but produced mechanically within a body, while DESCARTES is quoted as saying that heat is the movement of the parts of a body.

But we must bring our account of l'*Encyclopédie* and its attitude toward science and related fields to a close. While it was inevitable in the circumstances of the case that it should sometimes take up an inconsistent position or halfway attitude, on the whole it shows a brave and intelligent and fairly well sustained effort to maintain a critical and scientific attitude, and to free itself from the errors and unwarranted prepossessions of the past. To those who regard its « philosophy » as shallow we may answer in the words that D'ALEMBERT used in defending the old Greek atomist from the charge of madness, words which not inaptly describe the spirit of l'*Encyclopédie* itself; « DEMOCRITUS a fool! He who, to say it here in passing, had found the most philosophic way of enjoying both nature and mankind, that is, to study the one and to laugh at the other » (78).

(*Columbia University, New York.*) LYNN THORNDIKE.

(77) For example, in the article *Charbon* (*Chimie*) by VENEL we read, « comme mixte inflammable fixe, il fournit au Chimiste le principe du feu ou le phlogistique. »

(78) « *Experimental* »; « DÉMOCRITE fou! lui qui, pour le dire ici en passant, avoit trouvé la manière la plus philosophique de jouir de la Nature et des hommes; savoir d'étudier l'une et de rire des autres. »

Frederic Harrison

Mr. Frederic Harrison, who died in January 1923, was born in 1831. He remembered the accession of Queen Victoria and was, at his death, the most complete representative of the Victorian Age in the world. He owed this position to an extraordinary vigour and receptiveness which, in a general summing up of his character and work, will appear more salient than even his acceptance of Comte's philosophy in the fifties. The latter gave him the main direction and coherence of his life, but its varied interests, incessant activity, retentive memories, nobility of aim, and disinterestedness of action were his own alone.

It was through these personal qualities that, having once avowed himself an adherent of the Positive Philosophy, he soon became and remained to the end its best known exponent in English-speaking countries. He tells us in his Memoirs of the little circle at Wadham, the Mumbo-Jumbo, which breakfasted together every Sunday morning and discussed all the problems of the universe. The members were Edward Spencer Beesly, afterwards Professor of History at University College, London, and an eminent publicist, John Henry Bridges, afterwards physician and Inspector of Public Health, the most philosophically minded of the group, and Thorley, the scholar, who later became Warden of the College. They were all much interested in the teaching and views of their classical and philosophical tutor, Dr. Richard Congreve. They gradually ferretted out the source of his inspiratoin, the recently published works of Auguste Comte. None of them added much to the teaching they thus received, but they all applied it in wider spheres and a more liberal spirit than the Tutor from whom they had first acquired it. Dr. Congreve was originally a clergyman in the Church of England and retained to the end the attitude of moral guide and director of consciences. When the first start in propagating Positivism in England was made in 1870, it soon assumed the form of a small chapel for religious services, in which the details of altar and reading-desk and pulpit all recalled the arrangements of a rather old-fashioned Anglican Church.

Against this, and the dictatorial tone of CONGREVE, HARRISON and his friends protested, and by 1879 had seceded to the much better known meeting-place at Newton Hall. HARRISON, BEESLY, BRIDGES and VERNON LUSHINGTON were the leading spirits in the secession, and for the best part of twenty years it was a resort from time to time of everyone interested in new ideas and progressive movements. But on the larger scale in Newton Hall, the movement did not survive the gradual dropping off of the able and devoted men who had initiated it. After the death of most of them, but before the death of FREDERIC HARRISON himself, the diminished society, under the leadership of S. H. SWINNY, had effected a reunion with the remnants of Dr. CONGREVE's Church, and the whole body returned to the original meeting in Chapel Street. Here they still remain, deprived this year (1923) by a tragic coincidence, of the guidance and labor of Mr. SWINNY who died at the end of August.

A brief survey of these origins, of the contemporary evolution of thought, will supply some explanation of the want of growth and the difficulty of maintaining even the small nucleus which had been established.

The great master-ideas of COMTE which had been a new gospel to the keen young men of the fifties and sixties, were gradually absorbed in the general philosophic and political atmosphere. Such were the positive foundation and growing unity of science, the need of applying science to the betterment of mankind, the conception of progress based on the concrete historical record of the race, especially in Western Europe, the formation of a world-organisation to deal with common human problems, the advent of republics in which the interests of the mass of the workers would be the leading thought.

All these things are now common-places in civilized thought, and their truth is attested by a hundred triumphs in the application of science, in the freedom and self-government of smaller nations, above all in the recent institution of the League of Nations. People became therefore less and less ready to accept them as the special teaching and prerogative of a small group of persons, attached to one little-known and rather unsympathetic thinker from a country with which for a great part of the period our relations have been, though never actively hostile, yet constantly strained.

Meanwhile, the corpus of science, which COMTE had digested or generalized in his *Philosophie Positive*, went on growing with increasing and overwhelming speed. The specialism of science which he had deplored in his writings, became so much aggravated that it

became impossible, or was thought impossible, for any one mind to master even one branch of the many main divisions into which scientific work had broken up.

Now FREDERIC HARRISON and his friends at Oxford were unfortunately least well equipped on the scientific side. None of them had had a scientific training in his youth, and those like CONGREVE, BRIDGES and HIGGINSON, who went through a course of science in later life in qualifying for medicine, never did any original scientific research. They carried no weight in the scientific world, and therefore the critics of Positivism in the ranks of scientific men were driven back for their material to COMTE's own views, which, in spite of their breadth and frequent pilosophic truth, were inevitably disfigured by numerous errors and certain prejudices, and offered many handles to misunderstanding. HUXLEY's contemptuous treatment, both of COMTE and of HARRISON, ill justified as it was, became possible only through this defect in the armour of the English champions of Positivism. Their college in Oxford had been in the seventeenth century the first home of the Royal Society, the alma mater of WALLIS and several men of mathematical and scientific eminence. In the nineteenth it had become a teaching centre for classical history and philosophy, which are the best elements in an English liberal education, but entirely divorced from modern scientific thought.

It is interesting to compare the contemporary evolution of positive ideas in France and Italy, and especially the latter. In Italy « positivism », owing to the differences in general education and mental atmosphere, has become the recognized description of the school of thinkers who base all their conclusions on science, and sharply distinguished from the « idealism » of CROCE, GENTILE and others. The English « positivism » is commonly regarded as a larger synonym for « Comtism »; it is the description of a new religion rather than of a strictly scientific outlook on the world. It is a difference due to the general mental atmosphere of the different countries and to the training of the men who espoused the cause in England.

Positivists are thought of in England mainly as the apostles of a disinterested public policy, aiming at justice and self-government for the weak, — whether nations or individuals, — at a strict standard of duty, at the service of Humanity without selfish rewards either in this world or another.

Of such a policy and such a religion FREDERIC HARRISON was all his life the constant advocate and the most eminent exemplar. His last and posthumous book, « De Senectute », is a very appropriate

epilogue. It contains essays reviewing the impressions of a well-spent and consistent life with the mellow wisdom of a man of 91. He does not exult in the triumphs of science, still less in results of its application to life. Rather he deplores them and looks back with longing to the quieter and more leisurely days when he toured the Continent in a diligence and tramped the mountain roads free from the dust and hooting of the motor. He became in fact somewhat of a « laudator temporis acti », though he still enjoyed the life and spirit of young Oxford and himself played cricket in a « Harrison » team, when well on in his own eighties.

This want of close contact with the advance of science and the subsequent organization of society certainly tended to strengthen the conservative or even reactionary side of his later character. He frankly disliked the spread of State-directed education and thought that the reading of books and the informal conversation of older with younger people, were the best of all educational methods. Of course he opposed the enfranchisement of women and all the feminist movement. And the Trade Unions for which he had fought the winning fight of the seventies became in their triumph an object of fear. The Irish cause which had in him one of its strongest supporters in the days of its weakness, completely alienated his sympathies by the violence and disorder through which the final settlement was reached.

The backward-looking aspect of his later years is connected with a want of active sympathy with the forward movement in science, for nothing so disposes one to a hopeful and forward aspect as interest in the onward march of the collective reason of mankind which finds in science its most perfect expression. Yet HARRISON'S name will always remain high on the roll of English publicists and literary men who have striven to reconcile the movement and conflict of their time with a general ideal of human progress. The general ideal stands firm and gains ground continually. When the historian of the future turns back to the nineteenth century to trace the evolution of this idea, he will find a mine of information and inspiration in the writings of a man who strove consistently to keep alive the best in the past while opening out his own mind and those of his contemporaries to the possibility of a noble life in the future for all his fellows : the service and the advance of Humanity dominated all his thought and work.

F. S. MARVIN.

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Empirical generalizations on the growth of mathematical notations.

I. Forms of symbols. — A. *Primitive Forms*: (1). Many symbols originated as abbreviations of words. Later, some of them (their ancestral connections being forgotten) assumed florescent forms and masqueraded as ideographic symbols. Examples: + (et), π (periphery of circle of unit diameter), ∫ (summa), *d* (differentia), *i* (imaginary), √ (radix ?), *log* (logarithm), *lim* (limit), ∼ (similar), *sin*, *cos*, *tan*, *sec*. (2). Others are pictographic or picture symbols, such as △ (triangle), ○ (circle), □ (square), || (parallel), ▱ parallelogram. (3). Others still are ideographic or arbitrary symbols: × (multiplication), ÷ (division), ( ) aggregation, ∴ (therefore), ∵ (since), = (equality), and letters (not abbreviates) representing numbers or magnitudes.

B. *Incorporative Forms*, representing combinations of two or more mathematical ideas and symbols, such as $\int_a^b$ in definite integrals, ${}_nC_r$ in the theory of combinations, $\lim_{x \to a}$ in the theory of limits, $f(x)$ in the theory of functions.

C. The preference for symbols which avoid double or multiple lines of type (as illustrated by $\frac{a^n}{b^m}$) is intensified by the decline of type-setting by hand and the increased use of machines.

II. Invention of symbols. — Whenever the source is known, it is found to have been individualistic — the conscious suggestion of one mind.

III. Nature of symbols. — (1). Some are merely short-hand signs which enable an otherwise long written statement to be compressed within a small space for convenient and rapid mental survey. (2). Others serve also in placing and keeping logical relationships before the mind. (3). Adaptability of symbols to changing view-point and varying needs constitutes superiority. The Leibnizian ∫ has admitted of incorporative devices in integration, such as the Newtonian

□ or $\dot{x}$ could not admit so easily. The first derivative $\frac{dy}{dx}$ lends itself readily to change into differentials by elementary algebraic processes.

IV. Potency of symbols. — Some symbols, like a^n, $\frac{d^n y}{dx^n}$, $\sqrt{n}$, $\log n$ that were used originally for only positive integral values of n, stimulated intellectual experimentation when n is fractional, negative or complex, which led to vital extensions of ideas.

V. Selection and spread symbols. — (1). While the origin of symbols has been individualistic, their adoption has been usually by non-conferring groups of mathematicians. As in other inventions, so here, many symbols are made, but few are chosen. The list o discarded mathematical signs would fill a volume. (2). In no branch of mathematics is the system of symbols now used identical with what any one inventor ever designed them to be; present notations are a mosaic of individual signs of rejected systems. Modern elementary algebra contains symbols from over a dozen different inventors. Excepting Leibniz and Euler, no mathematician has invented more than two ideographs which are universally adopted in modern mathematics. (3). Often the choice of a particular symbol was due to a special configuration of circumstances (large group of pupils, friendships, popularity of a certain book, translation of a text) other than those of intrinsic merit of the symbol. Thus the inferior ∴ was adopted in proportion after = had been introduced as the sign of equality. At times there existed other extraneous influences. Perhaps commercial relations with Hebrews and Syrians led the Greeks to abandon the Herodianic numerals and to adopt an inferior alphabetic numberal system. Friction between British and Continental mathematicians prevented England, to her loss, from adopting in the eighteenth century the Leibnizian calculus notations, in which the great analytical researches of Swiss and French mathematicians were being recorded. (4). Mathematical symbols cross linguistic borders less readily than do mathematical ideas. This observation applies to abbreviates and ideographs rather than to pictographs. The Arabs adopted no symbols used by the Babylonians, Greeks or Hindus (except probably the Hindu numerals), nevertheless the Arabs acquired the Babylonian sexagesimals, Hindu trigonometry, part of Hindu algebra, Diophantine algebra, and the Greek system of geometric axioms and proofs. The Arabic algebraic symbolism of the fifteenth century antedated the German *coss*, yet acquired no foothold

in Christian Europe. In the sixteenth century the Italian solutions of cubic and quartic equations were eagerly studied in Germany, but the Italian notation was ignored by the Germans. Sometimes even national boundaries between linguistically homogeneous peoples yield diversity of symbols. The notation 2.5 means $2\frac{5}{10}$ in the United States, and 2 times 5 in Great Britain; the notation 2·5 means 2 times 5 in the United States and $2\frac{5}{10}$ in Great Britain. (5). The rejection of old symbols and the adoption of new ones are greatly retarded by acquired habits. The symbol $\div$ for subtraction has persisted for 400 years among small groups of teutonic writers even though less desirable than the usual symbol —. (6). Mathematicians have uniformly resisted the general adoption of very lavish and profuse symbolism for any branch of mathematics. The eruption of symbols due to OUGHTRED, HÉRIGONE, RAHN, HINDENBURG has been followed by the adoption of only certain few of them. The PEANO-RUSSELL-WHITEHEAD school is too recent to afford data for generalization on this point.

VI. STATE OF FLUX. — The maxim of HERACLITUS that all things are in a state of flux applies to mathematical symbolism. During the last four centuries symbols of aggregation have undergone several changes. The $\vdots$ in proportion is now passing into disuse; the arrow as a symbol for approaching a limit is meeting with enthusiastic adoption everywhere.

VII. DEFECTS IN SYMBOLISM. — (1). Sometimes the haphazard selection by non-conferring groups of workers has led to two or more things being represented by the same symbol. One cannot interpret « dx » without first knowing whether it occurs in « algebra » or in the « calculus ». The sign $\sim$ may mean « difference » or « similar to » or « equivalent to » or « approximately equal to » or, in the case of $a_v \sim b_v$, that the ratio of a_v and b_v approaches a constant as $v \longrightarrow \infty$. (2). Often two or more symbols are used for the same thing, causing waste of intellectual effort. Algebra has a calculus of radicals and a calculus of fractional exponents, both covering the same field. Millions of children have been forced to master both systems. Here DESCARTES and NEWTON missed a splendid opportunity to prevent useless duplication. However, there are fields where a certain amount

of duplication is convenient and not burdensome; for instance in forms of derivatives, $\frac{dy}{dx}$, $f'(x)$, also $\dot{x}$ for $\frac{dx}{dt}$.

VIII. Attempted remedies. — In the early stages of the development of a special field of mathematics, competitive systems of notation afford opportunities for selecting the best, or for framing a pragmatic system embodying the strong features of competing systems. But there has been no authoritative jury of specialists to make the choice. The continued existence of rival systems has delayed progress by rendering the researches of one group of specialists difficult of mastery by others. The selections are made by local non-conferring groups and not by a representative international group. In the last quarter century a small international association tried for a world notation in vector analysis (1); the movement came to naught, partly due to the great war. A similar fate awaited an international committee appointed about 1913 to consider notations for potential and elasticity (2). The partial success in the adoption of an international notation for actuarial science points to the hope of greater future success through international endeavor. The National Committee on Mathematical Requirements recommends that the subject of symbols for elementary algebra and geometry in its report of 1923, be considered by a committee of the International Congress of Mathematicians. There being no great economic interests at stake, as there were in the selection of world units in electro-magnetic science, correspondingly slower progress must be expected in the universal adoption of mathematical symbols.

(*University of California*). Florian Cajori.

(1) See *Isis*, II. 173-182, 1914.
(2) See *Isis*, II, 183-90, 1914.

Wissenschaft als Einheit [1]

Wenn man sich in grossen Zügen die Entwicklung der Wissenschaft vergegenwärtigt, so lassen sich in ihrem Verlaufe mehrere Stufen unterscheiden.

Zunächst entstanden, besonders im alten Orient und in Aegypten, Kenntnisse, die man als vorwissenschaftliche bezeichnen möchte.

Sie erhoben sich zwar über die Ergebnisse der schon dem vorgeschichtlichen Menschen eigenen, naiven Anschauung und entsprangen vorzugsweise dem Bestreben, die Umwelt menschlichen Zwecken dienstbar zu machen. Doch handelte es sich im wesentlichen um Stückwissen, das noch durch kein einigendes Band zusammengehalten wurde. Im Anschluss an diese Stufe begegnet uns, und zwar zuerst im alten Griechenland, eine zweite. Sie ist dadurch gekennzeichnet, dass der Mensch die Welt der Erscheinungen nicht nur stückweise und des blossen Nutzens wegen in sich aufnimmt, sondern, dass er sie als Einheit in ihrem Zusammenhange zu erkennen sucht.

Dies geschah erstens dadurch, dass man die, Hand in Hand mit dem Naturerkennen entstehenden Anfänge der Mathematik auf die Ercheinungswelt anwenden lernte. Zum andern dadurch, dass man die Erscheinungen sofort auf ihre letzten Ursachen zurückzuführen suchte.

Diese frühesten Regungen des wissenschaftlichen Denkens erfolgten seit etwa dem 6. vorchristlichen Jahrhundert zunächst in den ionischen Kolonien, die ja zwischen der asiatischen Welt und dem eigentlichen Hellas eine vermittelnde Stellung einnahmen, dann aber auch in Griechenland selbst.

Zu den ersten, die das ganze Gebiet der Naturwissenschaften zu umspannen und es auf eine einzige Ursache zurückzuführen strebten, zählte Demokrit. Auf diesen folgte Aristoteles. Durch ihn wurde zum ersten Male ein das Universum umfassendes Lehrgebäude errichtet, das die Ergebnisse der bisherigen Erfahrung zwar unter

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(1) Antrittsvorlesung an der Universität Bonn, gekürzt.

starker Betonung des rein Begrifflichen, indes unter Vermeidung religiöser, mystischer und nationaler Vorurteile enthielt.

In diesem allgemeinen Zug liegt seine Bedeutung. Das war es, was ARISTOTELES die Wirkung auf die kommenden Jahrtausende sicherte.

In seinen Spuren wandelte, wenn auch bei weitem nicht an ihn heranreichend, PLINIUS, der sich rühmte, dass er als erster unter den Quiriten die Natur in allen ihren Teilen gefeiert habe.

Handelte es sich bei PLINIUS hauptsächlich um eine enzyklopädische Darstellung, so trat das noch mehr in den mittelalterlichen Sammelwerken zu Tage. Mit einer Fortbildung der Wissenschaften hatten diese nichts zu tun. Eine solche war eben nur möglich auf dem Wege der Einzelforschung, des Fachgelehrtentums. Auch darin hat das Altertum schon wertvolle Ansätze gezeitigt.

Als gegen den Ausgang des Mittelalters die Wissenschaft des Altertums zu neuem Leben erwachte, wiederholte sich der geschilderte Wechsel. Zuerst erblicken wir wieder Männer, die gleich ARISTOTELES die Wissenschaft als Ganzes zu umspannen suchen. Es waren das ALBERTUS MAGNUS, ROGER BACON und in gewissem Sinne auch LIONARDO DA VINCI, der in seinen Aufzeichnungen kaum ein Gebiet der Naturwissenschaften und der Technik unberührt liess, wenn sie sich auch nirgends zu abgerundeten Leistungen verdichteten.

Auch zu Beginn der Neuzeit blieb das Streben, die Natur als Einheit aufzufassen, noch ohne rechten Erfolg. Erst mussten in andauernder Arbeit die einzelnen Gebiete ausgebaut und manche noch erschlossen werden, bis endlich, seit etwa der Mitte des 19. Jahrhunderts, die einheitliche Auffassung der Natur und eine dementsprechende Darstellung der Naturwissenschaften und ihrer Geschichte sich immer mehr durchzudringen vermochten.

Was musste das 17. Jahrhundert, in dem jener Ausbau einsetzte, nicht zunächst alles leisten? Vor allem fehlte es an einer genügenden physikalischen Grundlage. Erst GALILEI schuf die Methode, die auf naturwissenschaftlichem Gebiete allein zum Auffinden des wahren Sachverhalts befähigt. Durch ihn kam das induktive in engster Verbindung mit der mathematischen Deduktion einhergehende Verfahren zu voller Geltung. Es sollte nicht nur der Physik sondern auch allen übrigen Wissenschaften, wie GALILEI einmal sagt, eine würdige Behandlung sichern.

Wie die Mathematik, so ist auch die Philosophie für das Zusam-

menwachsen der Naturwissenschaften zu einer Einheit von grossem Einfluss gewesen.

Trotz der engen Beziehungen, die zwischen den Naturwissenschaften, der Mathematik und der Philosophie bestanden, haben sich diese Wissenschaften übrigens keineswegs stets gegenseitig gefördert. Selbst die Mathematik hat die Naturwissenschaften zeitweilig gehemmt, indem sie letztere mit geometrischen und Zahlenspekulationen überwucherte.

Geradezu unheilvoll ist mitunter der Einfluss der Philosophie auf die Naturwissenschaft gewesen. Letztere hatte am meisten, erstere am wenigsten festen Boden unter den Füssen. Die Philosophie konnte daher besonders leicht auf Abwege geraten. Das ist bis in die neueste Zeit geschehen, wie der Einfluss der während der ersten Hälfte des 19. Jahrhunderts herrschenden Naturphilosophie gezeigt hat.

In Deutschland konnten die Naturwissenschaften erst zur vollen Blüte gelangen, nachdem sie sich von der zeitgenössischen Philosophie losgelöst und sich dem Ausbau ihrer einzelnen Zweige hingegeben hatten. Dafür, dass diese nicht zu sehr auseinander gingen, sorgten für die anorganischen Naturwissenschaften das um die Mitte des 19. Jahrhunderts zur allgemeinen Anerkennung gelangende Energieprinzip und für die organischen die scharfe Erfassung des Entwicklungsgedankens.

Einer einheitlichen Auffassung der Naturerscheinungen stand noch um die Wende vom 18. zum 19. Jahrhundert die Vorstellung von den Imponderabilien im Wege, die als Licht und Wärmestoff, als elektrisches und magnetisches Fluidum, als Phlogiston und Lebenskraft einen ganz ungenügenden Ersatz für den heutigen Kraftbegriff bildeten.

Erst gegen das Ende des 18. und während der ersten Hälfte des 19. Jahrhunderts wurden die erwähnten, einer einheitlichen Auffassung des Geschehens entgegenstehenden Vorstellungen überwunden. Ermöglicht wurde dies auch dadurch, dass jene, von der Philosophie schon frühzeitig entwickelte Ansicht vom Wesen der Materie, die man die atomistische nennt, auf den Rang einer naturwissenschaftlichen Theorie erhoben wurde. Daneben entwickelte sich die Lehre von der wechelseitigen Aequivalenz sämmtlicher Naturkräfte. Auf die kürzeste Form gebracht, lautet dies, seit 1850 etwa die Naturwissenschaft beherrschende Prinzip : « Die Energie des Weltalls ist konstant. » Seine Durchführung leitete auf eine immer innigere Ver-

schmelzung der verschiedenen Wissensgebiete. Man hatte das Prinzip zuerst aus irdischen Beobachtungen erschlossen. HELMHOLTZ stellte sich die Aufgabe, auf Grund des Prinzips von der Erhaltung der Kraft den « Haushalt des Weltalls » zu überschauen.

Aehnlich wie mit dem Heranwachsen der Wissenschaft aus ihrer Zersplitterung zur Einheit, verhält es sich nun auch mit ihrer Geschichte.

Der Drang sich auf ihre Geschichte zu besinnen, zeigt sich bei den einzelnen Wissenschaften umso früher, je einheitlicher sie sich darstellten. Deshalb begegnen uns die frühesten Versuche nach dieser Richtung auf den Gebieten der Mathematik und der Philosophie, während die Naturwissenschaften bei der geringen Fühlungnahme, die anfangs zwischen ihnen bestand, erst spät ihr Augenmerk auf ihre Geschichte lenkten. In dieser Geschichte steht dem Wechsel der Theorien als das Bleibende nicht nur das Reich der einwandfrei ermittelten Tatsachen gegenüber. Vom demselben beständigen Wert, wie sie, erweisen sich auch die Ueberlegungen, die zu ihrer Entdeckung und Verknüpfung geführt haben. Darin liegt vor allem die Bedeutung der geschichtlichen Betrachtungsweise. Sie stellt dar, was geworden ist und nicht, was wird und daher zunächst nur in unbestimmten Umrissen erscheint. Das unterscheidet die Geschichte der Wissenschaften von der Wissenschaft des Tages, die das letzte Glied der fast endlosen Kette einer hinter uns liegenden Entwicklung und der Anfangspunkt einer ebenso unabsehbaren Folge weiterer Entwicklung ist.

Eine Geschichtsschreibung, wie wir sie für die Naturwissenschaften brauchen, muss diese im Rahmen der allgemeinen Entwicklung darstellen. Das heisst : Ihr Werdegang ist nicht nur als ein Ergebnis der gesamten Kultur, sondern unter Bezugnahme auf die Entwicklung der übrigen Wissenschaften, insbesondere der Philosophie, der Mathematik, der Medizin sowie der Technik zu verfolgen. Vor allem ist zu zeigen, wie sich diese Zweige des Denkens und der Forschung gegenseitig gefördert und bedingt haben (1).

Einer solchen Art der Darstellung gegenüber wird auch das häufig noch anzutreffende Vorurteil schwinden, als ob eine Beschäftigung mit der Geschichte der Wissenschaften von wichtigeren Dingen

(1) Diesem Zwecke entspricht das Werk : F. DANNEMANN, « Die Naturwissenschaften in ihrer Entwicklung und in ihrem Zusammenhange. 4 Bde. Leipzig, W. Engelmann, 1920-1923.

ablenken könne. Nicht um eine Vermehrung des Wissenstoffes handelt es sich hier, sondern um eine Vertiefung und eine dadurch bedingte Erhöhung der Einsicht. Fachstudium und Einzelforschung sollen durch die Hineinbeziehung des historischen Elementes nicht etwa eine Einbusse erleiden, sondern gefördert werden. Deshalb ist die Geschichte der Wissenschaften unter Vermeidung allen irgend überflüssigen chronologischen und biographischen Beiwerks zu lehren. Auch ist nicht einmal zu wünschen, dass sich nun jeder auf Grund eingehenden Quellenstudiums einen Ueberblick über die Entwicklung der Wissenschaft verschafft. Ein solcher muss vielmehr, wie es doch auch auf anderen Gebieten geschieht, durch Lehrvorträge und geeignete Schriften, als etwas Fertiges geboten werden. Sie sollen das Ferment abgeben, das in dem einen mehr, im andern weniger wirksam ist, das aber der wissenschaftlichen, sowie der Allgemeinbildung in Zukunft nicht fehlen darf. Das Werden der Naturerkenntnis hat, um ein Bild Eduards von Hartmann zu gebrauchen, den Sockel zu bilden, auf dem sich die Kultur geschichte des Geistes als Statue erhebt.

Friedrich Dannemann.

(*Bonn.*)

Geschichtliches zur Ölbereitung aus Traubenkernen

Die Kenntnis der Oelbereitung aus Traubenkernen, zu der die Not des Weltkrieges wieder gezwungen hat (in Oesterreich wurde sie sogar gesetzlich gesichert), lässt sich bis ins 16. Jahrhundert zurückverfolgen und ist vielleicht noch älter. Im Jahre 1569 hat ein gewisser Johann Franz Rizo, kaiserlicher Diener und Musikus, eine Eingabe an Kaiser Maximilian II. gerichtet, in der er unter Betonung, dass « Ime der Allmechtige Gott gnaden vor anderen Menschen mitgeteilt », ein Privilegium für die Herstellung von Oel aus « Weinbeerkerlein » erbittet. Zur Unterstützung seines Anliegens bringt er vor, dass das Oelmachen in den österreischischen Ländern fremd sei und Oel mit grossen Kosten eingeführt werden müsse. In Niederösterreich sei das Material hiezu in den Traubenkernen reichlich vorhanden und bisher unausgenützt weggeworfen worden. Dieses Oel sei zum Brennen und zu anderen Dingen sehr gut zu brauchen. Der Kaiser gewährte dem Rizo wirklich am 10. Juli 1569 ein Privileg auf sechs Jahre und befahl ausdrücklich, dass man ihm beim Einsammeln der Körner « alle guete hilff und handraichung thuen » solle (1). Es ist nicht bekannt, ob Rizo von diesem Privileg Gebrauch gemacht und welche Erfolge er gehabt hat. Jedenfalls ist die Sache bald in Vergessenheit geraten. Dass Rizo die Erfindung nicht selbst gemacht, sondern aus Italien mitgebracht hat, wo diese Industrie sehr alt zu sein scheint, darf man wohl aus seinem welschen Namen mit Sicherheit erschliessen. Auch später ist die Anregung zur Traubenkernölerzeugung vermutlich immer wieder von Italien ausgegangen.

Das geht ziemlich deutlich aus einer hundertvierzig Jahre später erfolgten Eingabe hervor, durch die Adam Ignaz Höger ein Privilegium für die Herstellung von Brenn- und Speiseöl aus Traubenkernen zu erwerben trachtete; er gibt an, dass die Erfindung in Deutschland

(1) *Blätter des Vereines für Landeskunde von Niederösterreich*, IV, 1870, S. 27.

noch unbekannt sei. Am 22. April 1709 erfloss für Höger ein Privileg auf 25 Jahre, das dem Inhaber grosse Rechte einräumte. Er durfte die Traubenkerne von jedem unbehindert einsammeln und mautfrei in seine Fabrik führen. Diese sollte im Namen des Landesherrn selbst eröffnet und von Höger als kaiserlichem Administrator geleitet werden. Dafür hatte er von jedem verkauften Zuber Oel einen Gulden an das Aerar abzuliefern. Man hoffte auf diese Weise, das Brennöl und die Kerzen im Lande zu verbilligen und die Einfuhr fremder Oele zu unterbinden. Auf die Behinderung der Tätigkeit Högers war eine hohe Strafe gesetzt. Trotzdem hatte Höger mit ausserordentlichen Schwierigkeiten zu kämpfen, da sich die ländliche Bevölkerung gegen die Neueinführung stemmte. Man weigerte sich, die Traubenkerne abzuliefern, so dass Höger nach zwei Jahren die Arbeit einstellen und die Klage gegen seine Widersacher erheben musste. Die Kaiserin-Witwe Eleonora, damals Regentin für Karl VI., erliess daraufhin am 26. Oktober 1711 eine Verordnung, in der die Missachtung des kaiserlichen Patentes und die Behinderung Högers mit scharfen Worten gerügt und künftighin mit einer Strafe von hundert Dukaten bedroht wurde. Doch scheint das alles nicht viel geholfen zu haben, denn wir hören in der Folgezeit nichts mehr von Högers Unternehmung.

Erst in der zweiten Hälfte des 18. Jahrhunderts scheint man der Oelbereitung aus Traubenkernen im Norden der Alpen wieder Beachtung geschenkt zu haben. So empfiehlt sie Abbé Rozier in seinen « Observations sur la physique, sur l'histoire naturelle et sur les arts et métiers » (II, 1771, S. 206), unter ausdrücklicher Berufung auf deren häufige Anwendung in Italien. Als neue Erfindung wird das Verfahren hingegen irrtümlicherweise in der von der ökonomischen Gesellschaft in Bern herausgegebenen « Neuen Sammlung der physisch-ökonomischen Schriften » (II, 1782) angesehen. In gleicher Weise zählt es auch Lorenz Crell in seinem Journal « Die neuesten Entdeckungen in der Chemie » (IX, 1783, S. 253), offenbar zu den Errungenschaften der jüngsten Zeit ». Er versichert, dass man dieses Oel nicht nur zum Gerben, zu den Wollmanufakturen, zur Verfertigung von Seifen und zur Färberei sehr gut brauchen könne, sondern dass es auch vorzüglich und ohne üblen Geruch brenne. Um dieselbe Zeit erschien die « Zuverlässige Anweisung zur Bereitung des Trauben- Kern- Oehls, worin gezeigt wird, wie dasselbe nicht nur aus alten und gedörrten, sondern auch aus frischen und nicht ganz getrockneten Kernen gemacht werden solle » von Phillip Frie-

DRICH BINDER, Pfarrer in Haberschlacht, Brackenheimer Amt. Wann die erste Auflage dieser Schrift erschienen ist, konnte ich nicht ermitteln. Die zweite kam in Stuttgart 1787 heraus und erzielte grösseren Erfolg, da sie mehrfach besprochen wurde. So vor allem durch JOHANN BECKMANN, einen der um die Geschichte der Technik verdientesten Männer, aus dessen Anzeige in seiner « *Physikalisch-ökonomischen Bibliothek* » hervorgeht (XV, 1789, S. 292), dass sich der Herzog von Württemberg für die Sache interessierte. BECKMANN erwähnt bei dieser Gelegenheit auch eine um dieselbe Zeit erschienene italienische Schrift über den gleichen Gegenstand, die in der Società georgica di Monteccio nella Marca veröffentlicht wurde und berichtet, der Papst habe Oelpressen, wie sie in dieser Abhandlung beschrieben seien, in Rom bauen lassen. Auch den Publikationen ROZIERS und der Berner ökonomischen Gesellschaft hatte BECKMANN schon Aufmerksamkeit geschenkt (*Phys.-ökon. Bibl.*, V, 1774, S. 113; XII, 1782, S. 372). Ueber BINDERS Verfahren wird ausserdem in den « Schriften der Leipziger ökonomischen Gesellschaft » (VIII, S. 311), jedoch in ungünstigem Sinne Nachricht gegeben.

In Oesterreich wurde der vollständig vergessene Industriezweig zuerst wieder von der privilegierten Weinstein- und Weinessig-Fabrik in Nussdorf bei Wien aufgenommen. Kaiser LEOPOLD II. erteilte deren Besitzer STOPF am 8. Juli 1790 ein Privileg für die alleinige Herstellung des « ganz neu erfundenen und bisher ganz unbekannten echten Weinöls, dessen Güte und Nutzbarkeit bei allen Gelegenheiten in den damit verschiedentlich gemachten Versuchen sich bewährt hat ». Darüber berichtet JOHANN GEORG MEGERLE VON MÜHLFELD in seinem Aufsatze « Ueber die Erzeugung des Weinbeerkernöls » in den « *Vaterländischen Blättern f. d. österr. Kaiserstaat* » (1811, S. 518). Schon vor ihm hatte in der gleichen Zeitschrift (1811, S. 165) FRANZ SATTORI über « Glückliche Versuche zur Erzeugung des Weinbeerkernöls » gechrieben. Nach diesem Aufsatze hätte FERDINAND BENEDIKT LANG als Verwalter der Baron KLEBELSBERGSCHEN Herrschaft Grossöding in Steiermark, unabhängig von allen früheren — was aber kaum glaubhaft ist — die Herstellung des Weinbeerkernöles erfunden. Lang hätte seine Versuche auf der Herrschaft Schwanberg fortgesetzt und im Jahre 1793 mit den unbedeutendsten Auslagen 49 Pfund reines Oel erzeugt. « Er machte zugleich die Entdeckung, dass die Güte und Süsse des Oels mit der Güte und Süsse des Weines im Verhältniss stehe; dass die Kerne der Blautrauben ölreicher als jene der weissen seien; dass sich dieses Oel ohne

Nachteil der Gesundheit verwenden lasse und dem Mohn-, Kürbis-, Lein- und Kernöle vorzuziehen sei. Das Beispiel wirkte und es kam bald so weit, dass jeder Bürger und Berghold in Schwanberg solches Oel erzeugte und es genoss. » Lang legte seine Erfolge der Landesstelle vor, bekam eine Belobung und die Erfindung wurde im Jahre 1800 in den Zeitungen veröffentlicht. Allein das Interesse dafür scheint zunächst nicht über den engeren Kreis Langs hinaus rege geworden zu sein. Erst der Artikel Sartoris erzielte eine gewisse Wirkung. Wir erfahren aus den « Vaterländischen Blättern » (1811, S. 452), dass sich der Prälat von Klosterneuburg der Sache annahm und Lang zu einer Probevorführung einlud. Die Ankunft Langs in Klosterneuburg war für Ende November angesagt; für diesen Zeitpunkt wurden mindestens dreissig Metzen Kerne vorbereitet. Merkwürdigerweise ist über den Ausgang dieser Vorführung in den « Vaterlandischen Blättern » nichts mehr zu finden. Doch spricht davon wieder Stephan von Keess in seinem für die neuere Industriegeschichte Oesterrichs höchst wichtigen vierbändigen Werke « Darstellung des Fabriks- und Gewerbewesens im österr. Kaiserstaate » (Wien, 1823, I, S. 229). Er gibt an, dass Langs Versuche in Klosterneuburg die Vorteile einleuchtend machten, « die in *wärmeren Klimaten* mit der Erzeugung des Weinkernöls verbunden sind ». Man scheint also damals die Sache für niederösterr. Verhältnisse nicht geeignet gefunden zu haben. Keess berichtet ferner, dass in der Provinz Verona im Jahre 1817 nicht weniger als 5433 Zentner Weinkernöl gepresst wurden. Aus seiner Darstellung geht aber auch hervor, dass zu seiner Zeit die Bereitung von Weinkernöl im übrigen Oesterreich keine Rolle gespielt hat. Und so scheint es auch geblieben zu sein und bleiben zu wollen; denn das Kriegsintermezzo hat offenbar keine nachhaltige Wirkung gezeitigt.

Oswald Menghin.

(*Universität, Wien.*)

Notes and Correspondence

American Association for the Advancement of Science, 78th. meeting (Cincinnati, 1923). Section L. — The Cincinnati meeting took place from Dec. 27, 1923 to Jan. 2, 1924 and was very successful. Section L. is devoted to the Historical and Philological Sciences, but it has thus far been organized only with reference to the History of Science. The chairman of the section was FLORIAN CAJORI, the retiring chairman, WILLIAM A. LOCY, the secretary, F. E. BRASCH, and the following were members of the section committee : L. C. KARPINSKI, WALTER LIBBY, F. CAJORI, G. SARTON (absent).

I append a brief report by the secretary : « The Saturday forenoon session (Dec. 31) was devoted mainly to the very prominent part played by Cincinnati in astronomy, terrestrial magnetism and meteorology. Dr. W. CARL RUFUS, of the University of Michigan, dealt with the early history of American astronomical observatories, with special attention to the Cincinnati Observatory, founded in 1843 — five years before the organization of the A. A. A. S. The cornerstone was laid by President JOHN QUINCY ADAMS, when he was 76 years old, who made the then very arduous trip from Boston for the purpose. The first director of this pioneer observatory, ORMSBY MCKNIGHT MITCHELL, was a leading astronomer of his period. He founded the first astronomical society and the first astronomical journal in America. Dr. LOUIS A. BAUER, Director of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, a graduate of the University of Cincinnati, delivered an address on the early history of terrestrial magnetism in America. A leader in the early days of this science was Dr. JOHN LOCKE, a Cincinnatian who was among the organizers of the A. A. A. S. in 1848. He contributed largely to the study of magnetic dip and intensity and proposed that Cincinnati be made the center of reference for a magnetic survey of the United States. LOCKE's most important work was the invention of the chronograph (first known as « automatic clock register ») for which he received an award from Congress. Dr. W. J. HUMPHREYS, of the U. S. Weather Bureau, gave an inspiring account of the early history of American meteorology, pointing out that the true beginning of the U. S. Weather Bureau was made in Cincinnati.

Dr. CLEVELAND ABBE, then director of the Cincinnati Observatory, began to issue weather predictions in 1868. ABBE was subsequently a very prominent worker in the Weather Bureau and took part in all lines of meteorological advance. Professor EDWIN W. SCHREIBER, of Proviso High School, Mayfield, Illinois, contributed an illustrated paper on « Drawing Instruments of Two Hundred Years Ago ». Special attention was directed to EDMUND STONE'S edition of NICOLAS BION'S work on « The construction and principal uses of mathematical instruments », 1723. Dr. FLORIAN CAJORI'S address as retiring chairman was omitted, because of lack of time.

The Monday afternoon (Jan. 2) program was arranged jointly with the Philological Committee and was devoted to a symposium on FRANCIS BACON'S scientific writings, with special reference to celebrating the three hundredth anniversary of the publication of his *De Dignitate et Augmentis Scientiarum*. Five papers dealing with the activities of BACON as the originator of modern scientific methods were read and discussed before an interested audience. Professor MARK H. LIDDELL, of Purdue University, outlined a college of research projected by BACON, but never realized. Professor HARRY E. BARNES, of Smith College, developed the historical setting of BACON'S work. It was interestingly brought out that, while there were many bright lights in the period that we consider as the Dark Ages, the Renaissance and the Reformation, yet the general intellectual plane of BACON'S day was that based on ARISTOTLE and PLATO. Research was generally unknown and BACON'S turning to the experimental method for seeking truth — the observation of particulars in their regular series and order — blazed the way for the development of modern science. Professor W. A. CROWLEY, of the University of Cincinnati, outlined the practical value of Baconian induction, and was followed by Professor LOUIS T. MORE, of the University of Cincinnati, with an interesting paper on Philosophical limitations of modern science. Professor MORE called special attention to a very prevalent tendency to take evidence at second hand and assume as proved principles whose logical basis is questionable. The session closed with a paper by Dr. FLORIAN CAJORI, of the University of California (Chairman of the Committee on the History of Science), summing up some modern applications of Baconian method. »

This was the fourth meeting of section L of the A. A. A. S., the three former meetings being : Chicago 1920 (*Isis* IV, 208), Toronto 1921 (*Isis* V, 305), Boston. 1922. The next meeting (Dec. 29, 1924) will occur in Washington. G. S

The teaching of the history of science at the University of London. — There is at University College a full professorship of « Logic and Scientific Method » held by ABRAHAM WOLF, who for many years has been giving elementary lectures on the history of science. Most unfortunately directly after WOLF's appointment his health failed and he is now (Jan. 1924) abroad on an eighteen months leave. CHARLES SINGER has been charged with that part of his work which bears on Scientific History and Method during his absence. — But what is more important, the History and Method of Science has been fully recognized by the University and a research school has been established. Six students are even now preparing theses for the degree of Ph. D. under SINGER's direction.

To understand the kind of recognition given to our studies in London, a brief explanation of the conditions obtaining there, is necessary. London University at the moment is undergoing a process of evolution as regards its degrees. The present system is to give a degree of B. A. or B. Sc. after three years of study from the date of Matriculation. The new move, which is accepted in principle, is that those who wish to study for a fourth year can take a special course for which they will get no special degree (which is all to the good), but which will end in an examination in which people will be placed in classes. All those who require to understand it do understand perfectly the difference between, first, the examination at the end of three years and the second examination at the end of four years. The method is an almost exact imitation of that adopted at Cambridge, where the two examinations are spoken of as Tripos Part I and Tripos Part II. An examination in the Principles, History and Method of Science will be a Part II (fourth year) subject. It will only be accessible to those who have already taken a B. Sc. degree. The students will probably be asked to elect either for the Physical and Mathematical or for the Biological side and they will be given a certain choice of curriculum according as they chose one or the other. There will, of course, be a good deal of ground common to both.

The University of London is managed, so far as its academic curricula are concerned by Boards of Studies, the members of which are nominated partly by the Senate, partly by the Teachers, partly by the Board itself as so chosen. A special Board of Studies has been constituted for the « Principles, History and Method of Science ». This Board is preparing a syllabus for the examination of which I spoke above. It hopes to get the subject into full working order by the autumn of 1924, but certainly by the autumn of 1925.

The Board, as at present constituted, includes the following members : ALFRED NORTH WHITEHEAD, chairman ; CHARLES SINGER, secre-

tary ; A. J. Allmand ; Sir W. M. Bayliss ; A. L. Bowley ; A. Dendy ; J. W. Evans ; Henry Head ; G. D. Hicks ; L. T. Hobhouse ; G. B. Jeffery ; E. Wm. MacBride ; J. I. O. Masson ; A. P. Newton ; T. P. Nunn ; F. W. Oliver ; Sir J. H. Parsons ; J. R. Partington ; J. A. Platt ; G. E. Smith ; A. Wolf ; D. O. Wood ; E. N. da C. Andrade ; A. G. Little ; Sir N. Shaw; Graham Wallas. A very fine committee indeed wherein the most important branches of science are represented.

To conclude this account of the academic work done in London, I should say at least a few words of the seminar on the « History of Anatomy » conducted with so much authority by our indefatigable friend Charles Singer. It was attented by about 13 older students, including two Americans. The following extract from a letter of his may give one an idea of the kind of work done under his direction in this seminar. « My system is to avoid everything in the nature of a Lecture and to sit quietly discussing matters round a table. For each Session I prepare a series of very elaborate and complete notes. These notes contain many quotations translated from various languages and many of them from books which are not easily accessible. The students can take them away with them and can add their own memoranda during the discussion. I enclose a set of those which I have distributed this term, which, as you will see, contain a considerable amount of research on my part. They form in fact the first part of an outline of a « History of Anatomy » which I have undertaken to write. I think you will be specially interested in the Alexandrian section. »

These activities are not paralleled, as far as I know, in any other university and are very promising indeed. However, I hope to be able to publish in forthcoming numbers of *Isis*, similar accounts relative to other universities of the Old or of the New World.

George Sarton.

Un grand traité d'histoire de la philosophie. — Francesco Orestano, professeur à l'Université de Palerme, vient de prendre l'initiative de la publication d'un grand traité d'histoire de la philosophie qui semble devoir dépasser comme importance tout ce qui a été fait jusqu'à ce jour dans ce domaine. Il a réuni un groupe nombreux de collaborateurs parmi ses collègues des universités d'Italie, et chacun d'eux se chargera du rameau de l'histoire de la philosophie pour lequel sa compétence est la plus marquée. La direction générale de l'œuvre reste confiée à Fr. Orestano, qui m'écrit que la publication commencera en 1924 et sera menée rapidement C'est là, en effet, une des

conditions indispensables pour conserver l'unité désirable dans une publication documentaire aussi monumentale.

Le travail, dont chaque chapitre sera construit sur le même plan, est distribué de la façon suivante : pour la philosophie orientale, on a réparti la matière par langue; pour la philosophie de l'Occident, exception faite pour le XIX^e^ siècle, la division est basée sur le critère : époque; enfin, pour la philosophie contemporaine, on distingue les divers courants de la pensée philosophique. Voici quelle est la répartition des sujets entre les différents collaborateurs :

Philosophie orientale : *hindoue*, A. BALLINI; *sino-japonaise*, G. VACCA; *égyptienne*, G. FARINA; *assyro-babylonienne*, G. C. TELONI; *perse ancienne*, R. PETTAZZONI; *byzantine*, S. G. MERCATI; *syriaque*, G. FURLANI; *arabo-chrétienne*, G. FURLANI; *arabo-musulmane*, C. A. NALLINO; *judaïque*, U. CASSUTO. — Philosophie occidentale : *protohellénique* et *présocratique*, E. BODRERO; *grecque* (période culminante), G. ZUCCANTE; *post-aristotélicienne* et *hellénistique*, E. BIGNONE; *patristique* et *scolastique*, E. BUONAJUTI; *philos. de la Renaissance*, E. TROILO; *philosophie moderne* (jusqu'aux épigones de KANT), F. ORESTANO. — Philosophie contemporaine : *positivisme* et *évolutionisme*, G. MARCHESINI et L. LIMENTANI; *contingence*, *intuition*, *pragmatisme*, A. ALIOTTA; *néo-criticisme* et *néo-idéalisme* (en Amérique et en Angleterre), A. FAGGI; *idem*, (en Allemagne, France, Italie), E. P. LAMANNA; *philosophie des sciences biologiques*, FR. DE SARLO; *philosophie des sciences physiques et mathématiques* (non encore attribué); *matérialisme historique*, R. MONDOLFO; *individualisme*, G. VIDARI; le chapitre relatif au *néo-thomisme* manque, lui aussi, de titulaire.

Ce partage de la matière est rationnel. Puissent ORESTANO et ses collaborateurs mener à bien leur effort; ils auront utilement servi la cause du nouvel humanisme

L. G.

An Institute for the History of Science. — Some readers may remember the proposal to create in America an « Institute for the History of Science and Civilization », which I published a few years ago (1). Some time later America entered into the war, the idea of creating such an institute became preposterous and the whole thing fell flat. I have not given up my scheme and will publish a new edition of it, corrected and augmented, as soon as I will feel that a sufficient number of people are ready to understand it and to help me carry it through. The time has not come yet. Our country is exceed

(1) *Science*, vol. 45, 284-6; vol. 46, 399-402, 1917.

ingly rich, but as far as pure science and disinterested research are concerned, our richness is potential rather than actual. The amount of money devoted by us to pure scholarship is incredibly small as compared with almost any other expenditure. But matters are changing fast and there is every reason to believe that America will soon understand more fully the spiritual responsibilities involved by its material power and will gradually undertake a part of the intellectual work of the world more in keeping with its numbers, its size, its wealth, — its past.

In the meanwhile, similar plans are made in other countries and I am glad to reproduce below one sent to me by Prof. FRIEDRICH DANNEMANN, whose valuable textbook on the history of science has been often discussed in *Isis* (1). I had first thought of Englishing his plan, but upon further consideration it has seemed best to have it in the original German.

Ein Institut für die Geschichte der Naturwissenschaften und der Technik.

Zu einem Institut der in der Ueberschrift genannten Art möchte der Verfasser dieser Zeilen anregen. Es soll gleichzeitig Gelehrten jeder Nationalität, auch Studierenden, als Studienheim dienen und dadurch eine genügende Verzinsung bieten. Gedacht ist das Institut in einem anmutig im Walde (mit Alpenaussicht) gelegenen Vorort Münchens (Grünwald). An diesem haben sich schon zahlreiche Ausländer angesiedelt. Die Gegend ist auch geologisch, geschichtlich und touristisch hochinteressant. Vor allem soll aber das Institut zum Studium der Münchener Museen und Bibliotheken, besonders zum eingehenden Studium des grossen Deutschen Museums für die Geschichte der Naturwissenschaften und der Technik anregen. Das geplante Institut hätte unter anderem die Aufgabe, gegentliche Ferienkurse, wie man sie in England eingerichtet hat, zu veranstalten. Auch in England hat man sie aufs Land verlegt. Dort vereinigen sich die Teilnehmer eines solchen Kursus in einem Studienheim, wie zu einer Familie oder einer kleinen Gelehrtenrepublik. Die Zeit ist nicht nur der geistigen Arbeit, sondern auch der gemeinsamen Erholung gewidmet. Seine Besucher könnten sich in regen Gedankenaustausch dem Studium und unter bester Anleitung durch die Gelehrten des Instituts dem Besuche der Sammlungen des Deutschen Museums widmen. Auch dazu, dass die in Wissenschaft und Technik führenden Geister der verschiedenen Nationen einander nähergebracht und etwa schon vorhandene Fäden

(1) See *Isis* II, 218; IV, 110, 563; V, 198; VI, 115. A paper of his on the Unity of Science is included in the present number.

wieder angeknüpft würden, könnte ein solches Studienheim zusammen mit dem Institut beitragen.

In Deutschland fehlt es augenblicklich an Mitteln zur Durchführung des Gedankens. Nur ein sehr geeignetes Grundstück stände Kostenlos zu Gebote. Für einen ansehnlichen Bau, der etwa vierzig Personen Aufenthalt bieten könnte, würden 30,000 £ genügen (In Aktien von 50 £ geteilt). Wer sich an diesem wissenschaftlichen Unternehmen beteiligen will, möge sich wenden an Dr. F. DANNEMANN (Universität Bonn, früher wiss. Mitarbeiter am Deutschen Museum; Adr. Barmen, Rheinprov., Farbmühlenstr. 1).

G. S.

Note on the transliteration of Arabic. — The cost of printing has increased so much that it is no longer practicable to allow each contributor to introduce special types of his own choice to represent various Arabic letters (1). I propose the use of the following symbols to represent the letters of the Arabic alphabet in its natural order :

', b, t, th, j, ḥ, kh, d, dh, r, z, s, sh, ṣ, ḍ, ṭ, ẓ, ', gh, f, q, k, l, m, n, h, w, y.

This alphabet recommends itself by its relative simplicity (2), the number of digraphs and dotted letters being reduced to its strict minimum. It is essentially the same as that adopted by the international *Encyclopaedia of Islâm*, the only differences being the following : use of q, instead of a dotted k, for qâf ; use of j instead of dj for jîm (3) ; use of double letters without underlining. It is easy to justify these differences : double or dotted letters should always be avoided when not absolutely indispensable ; j represents sufficiently well in English the sound of jîm and is not used to represent any other letter ; q is not used to represent any other letter than qâf and thus can represent it without any ambiguity (4). The underlining of double letters is not simply very expensive but it gives to the transliterated words a forbidding aspect and makes it more difficult for laymen to remember them. I propose to replace that underlining by the addition of foot-

(1) Of course this applies *mutatis mutandis* to other languages, but the case of Arabic being the most important deserves special consideration.

(2) The two supreme desiderata of any system of transliteration are consistency and simplicity. *Le mieux est l'ennemi du bien.*

(3) Some Germans represent that letter by four letters, dsch. Thus an innocent word like al-Ḥajjâj becomes absolutely formidable al-Ḥadschdschâdsch !

(4) Some English writers have an idea that q must be followed by an obligatory u. That is very confusing. Qâf should be transliterated by q alone.

notes in the very rare cases when two letters following one another are not the constituting parts of a digraph but independent (1).

As to the vowels, it seems simpler to represent the fatḥa by a, the kasra by i and the ḍamma by u without attempting a more refined indication of the correct pronounciation (2). Long vowels are indicated best by the use of circumflex accents, as circumflexed letters are already part of the printer's equipment.

The assimilation of the final l of the article with the so-called solar letters may be indicated or not in the transliteration (ash-shamsu or al-shamsu). There is some justification for each alternative and the matter is hardly worth discussing. But consistency is imperative. I prefer not to indicate the assimilation, because this indication is unnecessary for Arabic scholars and disturbing for others, but even more because I try to use as few dotted letters as possible (four of them are solar letters).

For the sake of scholars who do not know Arabic it is well to add a few words about the pronounciation of the transliterated alphabet the use of which I recommend. It should be remembered that the pronounciation which I indicate is approximative, not absolutely correct. However this approximation is sufficient for all except Arabic scholars. Moreover, any attempt to refine the orthoëpy is discouraged by the coexistence of many different pronounciations among the peoples speaking Arabic to-day.

The three *vowels* are pronounced in the Italian manner (or as in the English word *ruminant*). The following examples may help to distinguish between the *short and long vowels* : ask, father; pin, pique; push, rule.

Diphthongs : ai as buy, my; au as thou, how

Consonants : the letters b, t, d, f, k, l, m, w, y (that is w and y when consonantal) are pronounced as in English. The hamza (') is pronounced like the French h aspirée (les héros, la haine)

th hard th as in thing

j as in James, giorno; sometimes more softly as the French j in bijou.

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(1) Even as one would do in an English primer for foreigners apropos of such words as goatherd, misbandle, roadhouse, foghorn. Footnotes would warn them to pronounce goat-herd, mis-handle, road-house, fog-horn, etc.

(2) The use of other vowels is especially unfortunate at the beginning of words. For example, ʿUmar and ʿOmar get widely separated in the index much to the reader's confusion.

ḥ	strong h with friction (must be heard.
kh	like gh in Scotch daughter, or like German hard ch, Spanish j.
dh	soft th as in this.
r	as in English but always trilled, as distinctly uttered as the initial r (room) or the double r between vowels (merry).
z	as in zeal, maze.
s	as in kiss.
sh	as in shore, wash.
ṣ	emphatic s.
ḍ	upper palatal d.
ṭ	emphatic t.
ẓ	th said far back.

(These four dotted letters are pronounced with broad of tongue, the tip being held against the lower teeth).

ʿ (ain)	« This sound arises by squeezing the violently compressed glottis ». Must be heard. Young camels are the best instructors.
gh	sound of gargling.
q	deep emphatic k (the difference between k and q is great, but it must be heard) (1).
n	as in English but slightly nasalized before k as in sank; nb sounds rather like mb.
h	as in English, but always very distinct.

* * *

I hope that contributors to *Isis* will kindly follow this system of transliteration. I have no wish to oblige them to do so against their will. They may have « conscientious objections » which I would respect. But if they introduce new letters or new diacritical marks it is only fair that they do so at their own expense. I beg them to consider also the interests of readers who are not conversant with Arabic: each new system of transliteration disturbs them considerably and increases their difficulty in remembering Arabic names.

GEORGE SARTON.

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(1) Prof. D. B. MACDONALD, to whom I submitted this note, remarks that q may be the simpler sound. It is certainly so in the Turkish pronounciation. It is very remarkable that the Arabs transliterated the Greek kappa by means of qâf, not kâf. In any case the difference between the two letters is great.

Reviews

Jean Plattard. — Guillaume Budé (1468-1540) *et les origines de l'humanisme français*, 38 p. in-16, Soc. d'édit. *Les Belles Lettres*. Paris, 1923. [3 fr.]

Je vais me permettre de donner dans l'organe du *Nouvel Humanisme* un résumé assez long de cette très courte, mais très jolie plaquette, qu'orne la reproduction d'un portrait, conservé au musée de Versailles, du fondateur de l'humanisme français.

Jean Plattard, après avoir rappelé le souvenir des quelques esprits raffinés qui ont su, en France, avant Budé, goûter les œuvres antiques et essayer d'en imiter la beauté (Jean Salisbury, Abélard, Saint Bernard, au XII^e^ siècle; Jean d'Ailly, Jean Gerson, Nicolas de Clamenge, Jean de Montreuil, au XIV^e^ siècle), montre quel était l'état de l'humanisme en France vers l'an 1500. A l'exemple de l'Italie, on s'était mis sérieusement à l'étude du grec et du latin. En 1470, Guillaume Fichet, bibliothécaire du collège de la Sorbonne, installe la première presse parisienne, et imprime des modèles de style épistolaire, des traités de rhétorique. Son disciple Robert Gaguin enseigne la poésie latine. Jacques Lefevre d'Etaples (souvent appelé Fabri) prépare une édition de la *Logique*, de *l'Ethique* et de la *Politique* d'Aristote, en s'attachant à l'étude du texte même, et groupe autour de lui une petite société de prélats, de magistrats et de grands officiers de la couronne où apparaît, avec Pierre de Courthardy et Guy de Rochefort, le jeune Guillaume Budé qui, après avoir vaguement étudié le droit à Orléans et s'être adonné aux plaisirs de l' « escuyerie », s'était remis à l'étude à 23 ans, et venait d'apprendre le grec avec George Hermonyme et Janus Lascaris.

Budé entreprend d'abord la traduction de quelques opuscules de Plutarque, et tout en s'intéressant en même temps aux mathémati-

ques, refait son droit d'une façon originale en lisant le texte même des *Pandectes*, qu'il confronte avec la glose d'ACCURSE (XIII^e siècle), dont l'autorité était restée hors de conteste pendant deux cents ans. Cette étude, qui est un modèle de critique philologique, et qui parait en 1508 sous le titre : *Annotationes* GUILLELMI BUDAEI *Parisiensis secretarii regii in quattuor et vigenti Pandectarum libros ad* JOANNEM DEGANARIUM *cancellarium Franciae*, soulève les protestations des jurisconsultes. Mais BUDÉ se laisse si peu abattre qu'il publie en 1526 un second volume de commentaires des *Pandectes : Annotationes posteriores*.

Entretemps, il avait institué une enquête générale sur la valeur des monnaies anciennes. Cette enquête l'amène à la recension de trois manuscrits de PLINE L'ANCIEN, à la recherche du rapport des monnaies anciennes avec les monnaies françaises, à l'évaluation en livres françaises des sommes mentionnées dans les textes anciens, et à la transposition dans la vie courante, des poids, des mesures qu'il trouve dans ces textes. Le résultat de ces recherches où l'on trouve « les qualités propres au vrai savant : méthode rigoureusement appliquée, sens critique, goût de l'expérimentation, patience dans les vérifications », est exposée en 1515 dans *De Asse et partibus ejus libri quinque* GUILLELMI BUDAEI *Parisiensis secretarii regii*, dont tous les humanistes français célébrèrent les mérites.

BUDÉ, à qui ses publications ont donné quelque crédit, le met tout entier au service de l'humanisme menacé par l'hostilité des théologiens. Lorsqu'il devient garde de la bibliothèque royale et maître des requêtes ordinaires de François I^er^, il fait si bien qu'il gagne à la cause des bonnes lettres son roi qui, après maintes dérobades, institue en 1530 *le Collège des lecteurs royaux*, devenu au XVII^e siècle le *Collège royal de France*, et à l'époque de la Révolution le *Collège de France*. En 1529 il avait publié ses *Commentarii linguae græcae* qui l'ont fait considérer comme le prince des hellénistes. L'année suivante, bien qu'à ses anciennes charges soit venue s'ajouter celle de prévôt des marchands de la ville de Paris, il publie sous le titre *De Philologia* un dialogue qu'il imagine entre François I^er^ et lui, et qui est une apologie de l'humanisme. — A mesure qu'il prend de l'âge, il fait plus grande dans ses études la part de la philosophie, mais aussi celle de la théologie, et donne en 1534 un ouvrage dont le titre : *De transitu hellenismi ad Christianismum* est comme le symbole de cette évolution de son esprit.

Mais même à ce moment, BUDÉ « n'a jamais cessé de croire que les humanités devaient être étudiées surtout parce qu'elles polissent et adoucissent les mœurs et qu'elles sont capables, sinon de moraliser,

du moins de civiliser les hommes, de les rendre plus nobles et plus heureux »

Isis, où l'on pense que de même que l'histoire des littératures grecque et latine fut la source du vieil humanisme, de même l'histoire de la science sera la source du nouvel humanisme, *Isis*, pour laquelle « the New Humanism is essentially the humanization of science or rather its re-integration with the other elements of our culture » (1), est heureuse de saisir l'occasion que lui donne l'opuscule de JEAN PLATTARD pour saluer la mémoire de celui qui fut, avec ERASME dont il était l'ami, le premier zélateur de l'humanisme.

[Cette plaquette fait partie des travaux publiés sous le patronage de l'Association GUILLAUME BUDÉ que SARTON a déjà présentée aux lecteurs d'*Isis* (IV, 46-47), et qui ajoute maintenant à sa *Collection des Universités de France*, laquelle s'enrichit très rapidement, une *Collection d'études anciennes*, une *Nouvelle Collection de textes et documents*, et une *Collection de littérature générale*, dont fait précisément partie le BUDÉ de PLATTARD. L'adresse actuelle de l'*Association* GUILLAUME BUDÉ est : 95, boulevard RASPAIL, Paris, VI^e^]

L. GUINET.

Henry Dwight Sedgwick. — IGNATIUS LOYOLA. *An attempt at an impartial biography* XVI+399 p. New York, MACMILLAN, 1923.

Is it proper to review a biography of LOYOLA in *Isis* ? I believe, it is, if the biography is a good one, and SEDGWICK's assuredly is. In the first place, it is hardly necessary to emphasize the influence exerted by the Jesuit schools during at least two full centuries. For a long time, they were the best schools in Europe and the historian of science who would appreciate their civilizing power must needs return to their fountain-head. In the second place he who would understand Spain, must learn to know and love the three greatest men she has produced : LOYOLA, CERVANTES and VELASQUEZ. My main reason for speaking at some length of this biography, however, is the fact that it is a model of impartiality, of charity and wisdom with which every historian will do well to become acquainted. It is perhaps not as beautifully written as the life of MARCUS AURELIUS (1921, see *Isis* V, 148-149) — it is a pity indeed that the author did not take more pains to polish it — but the essential, to give the reader a faithful and living portrait, has been accomplished. SEDGWICK's imaginative sympathy enables him to see and to show the best there is in every great man, without any gush or reticence. He will not

(1) SARTON, *Isis*, V, 18.

hide anything (1) but after having explained the facts of each case completely he never forgets that in our judgments of other men, whether living or dead, we must always give them the benefit of our doubts.

The author believes that the date of IÑIGO's birth was more probably 1495, than 1491 (see p. 392). He gives a moving account of IÑIGO's conversion in 1521, of his self-dedication on March 24, 1522 at Montserrat, of the year of passionate labor spent at Manresa (1522-1523) where in all probability the first draft of the *Spiritual Exercises* (2) was made. After a brief recital of the pilgrimage to Jerusalem, SEDGWICK devotes a very interesting chapter to explaining that Saint IGNATIUS's activity was determined far more by his repugnance to the spirit of the Renaissance than by opposition to the Reformation. That seems very plausible and helps one to understand his complete volte-face of 1524. Saint FRANCIS' ignorance could not satisfy him any more ; he realized the need of study and did not hesitate — at his age (he was then at least 29 years old) — to start upon a twelve-year course of education, beginning in a grammar school at Barcelona and ending at the University of Paris. This proved the mettle of his heart. The author has many occasions also of showing how intensely practical IGNATIUS was, but it is well known that saints are among men the most practical.

Such a book is mighty good reading in a world whose main maxim seems to be « Safety first » and whose most conspicuous ideal is the hunger for money and comfort and fame

GEORGE SARTON.

Sir Lawrence Weaver. — Sir CHRISTOPHER WREN. *Scientist, scholar, and architect.* XVI+173 p., 16 pl. and other illustrations. London, Country Life, 1923.

The second centenary of WREN's death was duly celebrated on February 25, 1923, in various places of the world, and many publications remain as mementos of the devotion and gratitude of our con-

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(1) See p. 25 : « In view of the opinion popular among Protestants that Jesuits are inclined to equivocate, I shall set forth in full any equivocation, dissimulation or subterfuge, or suspicion thereof, that may appear in any of the sources of his biography... »

(2) Spiritual Exercises to conquer self and regulate one's life and to avoid coming to a determination through any inordinate affection.

temporaries to that great Englishman. The most important of these publications have been entered in my fifteenth critical bibliography (see *Isis* VI, 162-4). Some are sumptuous but none ist ruly important. Collections of essays and speeches, however beautifully illustrated, have no permanent value. Many of the speeches testify to the vanity of authors rather than to the greatness of the hero. Reading some of them I could not help thinking of CARLYLE's definition of WREN as « a great man of extraordinary patience with fools. » WREN's patience would have been severely tried if he had been obliged to attend those celebrations !

Sir LAWRENCE's book is a very modest account of WREN's life and works. It is not by any means the complete biography which WREN deserves, but at least it offers a connected and critical account, tolerably complete within its scope. Although it would hardly justify a long review, I am glad to be able to use it as a peg to hang a grievance on. For is it not a shame that while miserable politicians and personalities of the third order have been the object of extensive and pretentious biographies, the lives of some of the greatest English men of science are still imperfectly described ? There is no complete edition of NEWTON's works nor a satisfactory biography of him, but we are given year after year standard biographies, in two volumes, of the most insignificant individuals of both sexes.

As far as WREN is concerned, the situation can be summed up as follows. Leaving out the commemorative publications of last year (for which see *Isis* VI, 162-4 , we have in the first place the *Parentalia or Memoirs of the family of the* WRENS compiled by WREN's son, CHRISTOPHER (1675-1747) and published by his grandson, STEPHEN WREN, London, 1750 (newly edited from the original by E. J. ENTHOVEN with 25 drawings of WREN's churches by E. H. NEW, London, 1903). This is, of course, a source of great value : not a biography but a collection of materials. Then, in chronological order, the following biographies : JAMES ELMES. *Memoirs of the life of Sir Christopher Wren*. XXXVI+532+147 p., ill. London, 1823 ; *Wren and his times*, XIX+436 p. London, 1852. LUCY PHILLIMORE. WREN, *his family and his times with original letters and a discourse on architecture hitherto unpublished*. XVI+362 p. London, 1881. WILLIAM JOHN LOFTIE. INIGO JONES *and* WREN, *or the rise and decline of modern architecture in England* XVI+284 p., 50 pl. New York, 1893. LENA MILMAN. WREN XVI+367 p., 64 ill , London, 1908 (again 1911). None of these biographies is entirely satisfactory, especially with regard to the history of science. It is natural enough that the immortal architect of St. Paul attracted more attention than the ingenious and versatile scientist and inventor. Miss MILMAN devoted only a few pages to the scientific

side of his genius, but she included a fac-simile reproduction of PASCAL'S problem and WREN'S solution from a Ms. in Mrs. PIGOTT'S copy of the *Parentalia*. This Mrs PIGOTT was the last surviving direct descendant of CHRISTOPHER WREN, and her copy of the *Parentalia* was interleaved with many manuscript documents. Sir LAWRENCE WEAVER was able to collect enough money to buy it from her and deposit it in the Library of the Royal Institute of British Architects.

It is not necessary to analyze Sir LAWRENCE'S work, but I may mention that it contains a short note on PASCAL'S problem on the cycloid and WREN'S solution, an attempt at a WREN chronology (wherein many errors of Miss MILMAN'S chronology are corrected), and a note on some portraits of WREN.

WREN was born at East Knoyle, twenty miles west of Salisbury, in 1632. He went to Oxford and showed so much precocity and real genius in various branches of science that HOOKE said of him : « Since the time of ARCHIMEDES there scarce ever met in one man in so great perfection such a mechanical hand and so philosophical a mind. » This comparison seems a little extravagant. I would prefer to compare WREN with LEONARDO DA VINCI — for both were as deep as they were versatile, both were at once men of science and great artists. It is interesting to note that it is almost by accident that WREN became an architect, and a greater accident, the fire of London in 1666, was the opportunity of his life. As an architect, he remained an amateur to the end of his days, an amateur of genius, to be sure, whose excellent taste was happily combined with much common sense. Another great architect of his time, CLAUDE PERRAULT (1613-1688), was also an amateur and a versatile scientist ; he was primarily a physician who did notable work in anatomy and zoology and translated VITRUVIUS. To measure WREN'S uncanny activity, it will suffice to remember that most of his work was done within 30 years. The construction of St. Paul, it is true, took 35 years (1675-1710), but he constructed many other churches at the same time. In the year 1669, when he married, he was working on the plans of St Paul and *seventeen* other churches ! WREN was also one of the earliest apostles of town-planning. He had learned in France the value of planning on spacious lines, and he tried to apply this knowledge after the fire of London, making a new plan of the city, but his views could not prevail against the prejudices of the freeholders, and one is « constrained as the years go by to spend millions in re-creating small scraps of his scheme in the name of street improvements. »

The burden of my review is to insist upon the need of a complete biography of CHRISTOPHER WREN. May we not hope to have one for the time when the third centenary of his birth will be celebrated —

in 1932 ? One such good work by an honest and intelligent scholar would be worth more — and would be a greater monument to WREN's memory — than the collected orations of all the big wigs of England.

G. SARTON.

[**Haller, Albrecht von**]. — HALLERS Briefe an JOHANNES GESNER (1728-1777). Herausgegeben, eingeleitet und mit Anmerkungen versehen von HENRY E. SIGERIST *(Abhdl. der Königlichen Gesell. der Wiss. zu Göttingen, Math. Kl.*, Bd. XI, 2) VIII+576 p. Berlin, WEIDMANN, 1923.

This Latin correspondence, carefully edited by SIGERIST with plenty of very brief but sufficient foot-notes and a good index, is a welcome addition to our knowledge of scientific life in the XVIII. century. The MS. of it is kept at the Zurich library. The letters are addressed to JOHANN GESSNER (or GESNER) of Zurich (1709-1790), physician, physicist and botanist, founder of the Zurich botanic garden. A great number of subjects are dealt with, but without having read every letter, I have the feeling that botanical topics are far more numerous than others. A great many XVIII. century scientists are mentioned, but a good majority of them again are botanists. Thus this book will perhaps appeal more directly to botanists than to other scientists. It has, however, a great biographical value. HALLER and GESNER were intimate and life-long friends. They first met at the university of Leiden, where BOERHAAVE had attracted them, in the fall of 1726. Their correspondence began in 1728 and it extended to the time of HALLER's death. HALLER's last letter ends with the words : « Tu vero, amicorum antiquissime et optime, vale et me ama, dum vivo superstes. Bernae die 3. Dec. 1777 » ; he died on the 12th. of the same month. The letters are written without care. Thus he himself says in 1755 : « ego absque scopo ejus modi publicationis scribo, nulla cum cura nullove studio, pressus fere semper otii defectu », — a statement which we may well believe, but if this reduces the literary value of his correspondence, in some ways, it enhances its biographical value, its genuineness.

The letters from GESNER to HALLER have not been included in this publication, partly because of the lack of space, and partly because some of them are already available in the *Epistolae ab eruditis viris ad* ALB. HALLERUM *scriptae*, Bernae 1773-1775 (1).

(1) HALLER's correspondence with various botanists of Basel was edited by H. CHRIST in 1918 (*Isis* VI, 171).

Reading these letters to his friend brought the great man much nearer to me. And also, it made me realize more keenly the need of a good biography of him. ZIMMERMANN'S *Leben des Herrn von* HALLER (Zurich, 1755) is insufficient especially from the scientific point of view. The humanized scientist wants something better and Switzerland owes something more to one of her most illustrious sons. Would Dr. SIGERIST not undertake that noble task? GEORGE SARTON.

Benjamin Dayton Jackson. — LINNAEUS (afterwards CARL VON LINNÉ). The story of his life, adapted from the Swedish of THEODOR MAGNUS FRIES, and brought down to the present time in the light of recent research. XVI+416 p., illustr. London, WITHERBY, 1923.

The main source for the study of LINNÉ's life is the monumental biography wherein the late Upsala botanist THEODOR MAGNUS FRIES (1832-1913) gave us the results of investigations carried on at intervals during more than thirty years. (LINNÉ. *Lefnadsteckning*. Stockholm, FAHLCRANTZ, 1903, 2 vol. in 1, issued in XI parts) (1). JACKSON'S book is an English abbreviated adaptation of that Swedish work, but as I had no opportunity of examining the latter, I have no means of judging whether the adaptation is faithful and whether it contains valuable additions as the title suggests. Indeed on the back of the volume, JACKSON'S name is the only one to appear and it is by far the most prominent on the title page : this would suggest that JACKSON'S work is far more original than a plain adaptation is supposed to be. The Introduction tells us what has been left out of the original work, (namely many details of persons, places and things which are of little interest except to the Swedish reader); it does not tell what has been added to it. There is an additional note on LINNÉ'S birthplace, Rashult, based on LINDELL (1923), but it did not occur to me that the book contained any new information of essential importance.

However that may be, we owe to B. D. JACKSON the first English biography of sufficient size, of one of the greatest men of the XVIII. century. FRIES'S work being written in Swedish is practically unavailable to most botanists and scholars and we must be grateful to JACKSON to have given us some access to it even though it be only by means of an adaptation (2).

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(1) FRIES was also the first editor of LINNÉ'S correspondence (in progress). *Bref och skrifvelser af och till* CARL VON LINNÉ. Stockholm 1907 sq.

(2) B. D. JACKSON had already devoted many papers to Linnaen subjects in the *Proc. of the Linnaean Society*, 1887 sq. He wrote also a life of the British botanist GEORGE BENTHAM (1800-84), London, 1906, and he it is who compiled the *Index Kewensis* under the guidance of Sir JOSEPH HOOKER, 1895 sq.

The book is very readable and seems to contain the essential information which the average botanist and man of science may wish to have on LINNÉ, and much more. It is very interesting to note that LINNÉ (according to his own statement corroborated by many facts) « had placed before his mind certain objectives before he was twenty-three years old, and had executed all before he came back to Sweden in 1738 », (that is, eight years later). Those are the golden years of course, 1730-1738; those about which our curiosity is insatiable. It is during that period, in 1732, that LINNÉ undertook his memorable journey to Lapland. His residence abroad, mainly in Holland, falls within the same interval. It extended from 1735 to 1738, two years and half of such enormous activity, that it would be hard to find their equivalent in the life of any other man of science. During that short time, LINNÉ published, besides smaller treatises, no fewer than twelve or fourteen books (one of them, the *Hortus Cliffortianus*, a large folio of 500 p., Amsterdam 1737), the majority of which were epoch making. It is true he was splendidly helped by generous friends, chiefly CLIFFORD and GRONOVIUS, but the ability of making such friends was undoubtedly a part of his genius.

I was glad to reread on p. 254, with some new details, the story of the centigrade thermometer. LINNÉ had already prepared and used one thermometer of that kind while he was in Holland, for it was depicted in the frontispiece of the above-named *Hortus Cliffortianus*, 1737. CELSIUS did not describe his thermometer until 1742, and his scale was not the centigrade scale, but that scale upside down (his 0° corresponding to our 100°, and *vice versa*). The scale introduced by LINNÉ (that is our scale) was used regularly at the Upsala observatory from 1747 on. It was known abroad as LINNÉ's or STRÖMER's thermometer; LINNÉ called it the Swedish or « my » thermometer. Thus the centigrade thermometer was invented, not by CELSIUS, but by LINNÉ.

The story of LINNÉ's interest in the production of artificial pearls (p. 323) was entirely new to me. It seems that LINNÉ had been thinking of that ever since his visit to Purkijaur during his Lapland journey. « He had no opportunity of experimenting with the true pearl mussels, only using lake mussels, but even with these he had produced beautiful pearls ». His secret, as described by him to a national committee, was « to bore a small hole in the shell, and introduce a small round object of plaster of Paris or uncalcined limestone, attached to a silver wire and then fastened to the shell Round the introduced body the pearl substance was deposited, and after five or six years, one had true pearls as large as peas. Finally he showed five mussel shells thus treated, and also nine pearls thus produced.

These had been tested by a jeweller who found them to be quite beautiful, and of especial quality. The Committee reported, and recommended a national reward to LINNÉ of 12,000 dalers in silver [£ 900]. A sympathetic reception was accorded to this report, less with regard to the economic gain, than for the value as a natural history fact, deserving of honour and national reward. The Committee determined to find out how the money could be raised, but wrote down the reward to one half ».

LINNÉ had drawn up for his son's guidance a series of recommendations and he had collected on slips various edificating stories, the whole being entitled « Nemesis divina » (1). JACKSON's work contains a few extracts from this self-revealing document. I chose from among them the following (p. 306, 386). « There is no greater character than to be an honest man, »... « I gave myself no rest day or night. What had I for it? Call it wind, which is annihilated by another. Titles are wind, Noble, Knight, Archiater. »... « What is greatness, when the wheel of success turns? What is wisdom? To realize one's own ignorance. What is power? The foremost place among fools. What are riches? Guardianship for other fools. What are clothes? Parts in a comedy to frighten children. »... « 1765 at midnight between 22nd and 23rd July, my wife heard [somebody] outside our bedroom; it went into the upper chamber, my museum. Something went heavily to and fro. Wakened me, and I heard it also. I knew that nobody was there, the doors were locked, and the keys with me. After a few days I learned that my special friend and trusty commissary, CARL CLERCK, died the 22nd July at nine at night, and really the walk was so like his, that if I had heard it at Stockholm, I should have known him by his walk, but I was then at Hammarby, six miles from Stockholm [really about thirty-six English miles], »... « When LÖFLING (2) before starting for Spain, came to take leave of me, he stumbled [on the threshold] came not back. FORSKÅL likewise »

Among eight appendixes, the first one dealing with LINNÉ's (five) autobiographies and those containing the list of his main pupils and a

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(1) This MS. was discovered in 1844 at Kalmar and first published in 1848 by E. M. FRIES (T. M. 's father) in the *Botaniska Utflygter*, then again by T. M FRIES in 1878. It is written partly in Latin, partly in Swedish

(2) PETRUS LÖFLING, LINNÉ's most beloved pupil, to whom the *Philosophia Botanica* was dictated in 1750, died in 1756 at Mererecuri, Guiana, at the age of 27. — The Finn PEHR FORSKÅL was another diciple of LINNÉ's, he died at Jerim, Arabia, in 1763 at the same untimely age.

select bibliography are the most useful, but I would have liked one more giving a brief chronology. This would have been the more welcome, because the dates — that is the years — are not always clearly indicated in the text. GEORGE SARTON.

Frederic Manning. — The life of Sir WILLIAM WHITE, K. C. B., F. R. S., etc. With an introduction by Lord GEORGE HAMILTON. XVII+502 p., 1 portrait and illustr. New York, DUTTON, 1923. [$ 8].

WILLIAM WHITE (Devonport, 1845. 02. 02 — London, 1913. 02. 27) was one of the greatest naval architects the world has ever seen, and certainly no other had opportunities equivalent to his. In the sixties when his activities commenced, naval construction which had hitherto developed at a relatively slow rate, began to grow and change more and more rapidly. « Up to 1800 for centuries backwards there was little material change — either in design, construction, or propulsion — of sea-going ships. At the Battle of Trafalgar NELSON's flagship was forty years old, but she was one of the fastest, if not the fastest, line-of-battle ships afloat, so slow were our ancestors in initiating change or improvement. Between the years 1800 and 1860 iron began, though very slowly, to supersede wood in the construction of sea-going ships, and steam as a propelling agency was gradually dispossessing masts and sails. After 1860 each subsequent decade outdid its predecessor in the improvements and development of power — so much so that fighting ships were almost obsolete before they had completed their first commission. » These remarks are extracted from the introduction by Lord GEORGE HAMILTON who was First Lord of the Admiralty in 1885 and who then appointed WHITE Director of Naval Construction. WHITE's life thus covers the whole period of naval construction from the beginnings of steam propulsion and of the building of iron ships to the opening of the Dreadnought era (1905) and the fitting of the Mauretania with turbines (1907). He designed over 250 warships at a cost, including armament, of approximately $ 500.000,000. Perhaps his greatest achievement was the organization of the entire dockyard, engineering and armament resources of Great Britain. The biography, in strict chronological order, is very elaborate and seems very complete. It will interest naval engineers and captains, and historians of technology in general It will interest historians of science only indirectly. It is on the whole a melancholy tale, one which makes one suddenly realize that the progress of civilization is not as simple as one might think, but tortuous, full of mystery and menace. G. S.

Blaringhem, Louis. — PASTEUR *et le transformisme*, préface de J. COSTANTIN, XIV+261 p., in-8°, MASSON et C^ie^, Paris, 1923. [14 fr.]

Le titre donné à ce travail est bien fait pour piquer la curiosité, PASTEUR ne s'étant jamais occupé du transformisme, et ayant même probablement envisagé cette doctrine avec une certaine méfiance; ce qui n'empêche que ses découvertes biologiques constituent des documents de premier ordre pour la conception évolutionniste. L'intérêt du livre de BLARINGHEM qui servira peut-être effectivement, comme le note COSTANTIN, « à orienter les sciences biologiques sur des voies nouvelles et fécondes », réside dans les rapprochements ingénieux faits entre les travaux de PASTEUR et les théories biologiques actuelles.

Les travaux sur les formes cristallines des tartrates s'apparentent à ceux de JORDAN lorsque celui-ci distingue dans les espèces linnéennes des sous-espèces constantes et bien délimitées, à ceux de BERNARD DE JUSSIEU inventant la subordination des caractères (PASTEUR définit en effet la dissymétrie moléculaire par la déviation de la lumière polarisée). Ils s'apparentent également, dans les cas d'additions et de substitutions de bases minérales à l'acide tartrique, aux lois de MENDEL. Dans tous ces cas, l'espèce chimique ou biologique reste intacte.

Les cristaux de bimalate et ceux de bitartrate d'ammoniaque peuvent être considérés comme l'expression simplifiée des mosaïques hybrides vivantes décrites par NAUDIN dix ans plus tard; les tartrates des bases organiques actives, comme l'asparagine, se comportent comme les hybrides du blé et du seigle, comme les hybrides des tabacs. La molécule est cette fois atteinte, on se trouve en présence « d'une crise de mutation de l'espèce »; les mémoires sur l'acide racémique, sur les alcaloïdes des quinquina, sur l'alcool amylique, sur le sucre de lait sont rapprochés des travaux de DE VRIES sur l'*Œnothera Lamarckiana*, des expériences de STANDFUSS et de FISHER sur les papillons et de celles de l'auteur sur le maïs. — BLARINGHEM rapproche ensuite le complexe vivant : ver à soie corpuscules de la pébrine, des rouilles et des charbons intimement associés aux céréales, y voit une preuve de l'hérédité de complexes d'espèces vivantes, et une justification de la *Pangénèse* de DARWIN plus ou moins modifiée.

Des études de PASTEUR sur les ferments, les maladies microbiennes, de la technique des cultures dérivent les études actuelles de l'auteur sur le perfectionnement des céréales, par l'intermédiaire des recherches de HANSEN (1881-86) qui applique à la lettre les principes et les procédés décrits dans les *Études sur la bière* (1873), de celles de N. HJALMAR NILSSON (1895) sur la sélection méthodique des blés, avoines et orges, et de celles de W. JOHANNSEN (1902) sur les lignées pures.

Quant aux travaux sur l'atténuation du bacille du choléra des poules, sur celle de la bactéridie charbonneuse, ils peuvent conduire à l'étude précise de la question toujours controversée de l'hérédité acquise, question qui, d'ailleurs, change de sens si l'on admet avec PASTEUR, comme le fait l'auteur, que la forme n'est pas l'espèce, mais qu'elle n'est qu'une des multiples manifestations de l'espèce.

En somme, « par ses études sur les cristaux, PASTEUR nous montre la trame de tout ce qui constitue la stabilité de l'espèce, la permanence des germes ; par ses études sur les ferments, il nous découvre la plasticité de l'individu ». A l'heure actuelle, la technique des lignées pures qui dérive si directement de l'œuvre pastorienne, semble faire s'évanouir « la plupart des preuves en faveur d'une doctrine philosophique relative à l'origine et à l'avenir du monde organisé ; mais le transformisme expérimental devient une science propre; il donne les sécurités des sciences physiques et chimiques ». — On retrouve donc dans ce livre qui fait penser, appuyées cette fois sur les travaux du Maître, les conclusions auxquelles BLARINGHEM, pastorien de formation et de conviction était arrivé dans ses travaux antérieurs, et notamment dans ses *Problèmes de l'hérédité expérimentale* (v *Isis*, III, 295).

L. GUINET.

Gustav Pfannmüller. — *Handbuch der Islam-Literatur.* Berlin, 1923, WALTER DE GRUYTER & Co. VIII und 436 S. Grundzahl 15.

Der Verfasser dieser Islam Bibliographie kennzeichnet im Vorwort die Entstehung und den Zweck des Werkes. Er hatte sich während des Krieges mehrere Jahre im Auftrag der Deutsch-Türkischen Vereinigung in Berlin den jungen Türken gewidmet, die als Schüler oder Studenten nach Darmstadt gekommen waren, wo der Verf. als Bibliothekar der Landes Bibliothek seinen Wohnsitz hat. Um sich selbst besser zu dieser Aufgabe vorzubereiten, hörte er an der benachbarten Universität Frankfurt a/M. und in Darmstadt selbst Vorlesungen über die Religion und Kultur des Islams sowie über die türkische Sprache, und arbeitete sich in den folgenden Jahren immer mehr in die Literatur über den Islam ein. Unterstützt wurde er durch die reichen Bestände der Darmstädter Bibliothek, die dank der tatkräftigen Leitung ihres Direktors Dr. A. SCHMIDT planmässig ergänzt wurden. Wie das Buch aus einer allmählichen Sammlung des Stoffs entstand und den Verfasser selbst immer tiefer in die unendlich reiche Welt des Islam einführte,so will es auch allen, die sich ernstlich mit der Kultur des Islam beschäftigen, eine erste Einführung und Handreichung zum Studium geben.

Das Buch geht insofern über die gewöhnliche Form von Bibliographien hinaus, als es die nach kleinen Sachgruppen geordneten Titel

durch Analysen des Inhalts der wichtigsten Werke und durch Einreihung der besprochenen Werke in den Gesamtzusammenhang der Islamwissenschaft für den Rat suchenden Benützer kennzeichnet. Wir erhalten also eine Art Literaturgeschichte des Islam, die sich nicht direkt auf die Literatur stützt, die der Islam selbst hervorgebracht hat, sondern die Entwicklung und den Wandel der Urteile darstellt, die die europäischen Gelehrten der letzten Jahrhunderte über den Islam, seinen religiösen Wert, seine weltgeschichtliche Bedeutung und seine allgemeine Kulturleistung gefällt haben.

Man wird dem Verfasser bezeugen müssen, dass er sich seiner mühevollen Aufgabe mit Geschick und Takt unterzogen hat, und dass sein Buch insbesondere für Studenten, die nicht nur ein paar Brocken Arabisch oder Türkisch lernen, sondern in die islamische Kultur eindringen wollen, ein überaus wertvoller Führer und Ratgeber ist. Ein solches Handbuch, das in der ungeheuern Literatur eine Wegweisung bietet, die den Suchenden an die wichtigsten Themen und ihre Bearbeitung heranführt, das ihm zugleich in den zusammenhängenden Inhaltsangaben eine erste Orientierung über den Gang und gegenwärtigen Stand der Einzelfragen darbietet, ist in der Tat ein aufs dankbarste zu begrüssendes Werk. Es füllt eine Lücke aus, die besonders auch der akademische Lehrer empfinden musste, der zwar aus eigenem jahrzehntelangem Studium den grössten Teil dieser Literatur kannte, aber dem angehenden Arabisten und Islamstudenten nur in unzulänglichem Ausmass mitteilen konnte. Mit dieser Bibliographie, die eher eine Literaturgeschichte genannt werden könnte, und C. Brockelmanns Geschichte der arabischen Literatur, die eigentlich nur eine Bibliographie ist, sind jetzt zwei Grundwerke gegeben, die den künftig in den Urwald der islamischen Literatur Eindringenden ein grosses Stück Arbeit abnehmen werden.

Eines allerdings darf dem Pfannmüller'schen Werke gegenüber nicht ungesagt bleiben, besonders nicht in einer Besprechung, die in einer der Geschichte der Wissenschaft und Kultur gewidmeten Zeitschrift erscheint: es ist ein empfindlicher Mangel des Buches, dass der Verfasser, als wesentlich theologisch-philologisch vorgebildeter Bibliograph, den Begriff des Islam in seinem engsten religiösen Sinne fasst, also für die im und durch den Islam geschaffene *weltliche* Kultur und die von ihm hervorgebrachte Blüte der Wissenschaft nur unzulängliche Angaben macht. Natürlich ist es das gute Recht jedes Schriftstellers, das Gebiet, das er umfassen will, selbst zu bestimmen, und der Verfasser hat auch im Vorwort keinen Zweifel darüber gelassen, dass das Hauptinteresse seiner Arbeit der Religion, nicht den weltlichen Schicksalen und Leistungen der Bekenner des Islam zugewandt sei. Aber wäre es nicht doch möglich gewesen, die andere Seite

der Erscheinung des Islam auch zu ihrem Rechte kommen zu lassen? Ist es nicht ein gar zu einseitiges Bild von dem geistigen Leben im Islam, wenn von den 420 Textseiten der Bibliographie 348 Seiten der Religion, dagegen nur acht der Philosophie, vier der wissenschaftlichen Literatur der Perser, Araber und Türken gewidmet sind? Man wird also sagen müssen, dass uns zu dieser geistlichen Bibliographie das weltliche Seitenstück fehlt, und wenn es heute in Deutschland ausgeschlossen scheint, ein solches Werk durch den Druck zu führen, so möchte ich doch die Hoffnung nicht aufgeben, dass diese unerlässliche Ergänzung der PFANNMÜLLER'schen Arbeit in England oder Amerika vorbereitet wird. Es ist kein Vorwurf, den ich dem Verfasser dieses so überaus dankenswerten Werkes mache, aber ein Vorwurf gegen die ganze derzeitige Islamphilologie, dass sie an der gewaltigen Leistung des Islam auf dem Felde der *Wissenschaften* fast so teilnahmslos vorübergeht, wie der Priester und der Levit an dem Manne, der auf dem Weg nach Jericho den Räubern in die Hände fiel, und dass der barmherzige Samariter, der sich des armen Geschlagenen annimmt, nicht als voll gilt in der Gesellschaft der Priester der Islamkunde. So bleiben Kräfte ungenützt, die mit ein klein wenig gutem Willen freigemacht, Forschungen unvollendet, die zu weittragenden Ergebnissen geführt werden konnten. Den Schaden aber hat die Geschichte der Wissenschaften nicht nur im Islam, sondern in ihrer Gesamtheit. Denn soviel leuchtet wohl auch dem Philologen ein, dass eine Geschichte der europäischen Wissenschaft vom 11. bis zum 17. und 18. Jahrhundert nicht geschrieben werden kann ohne Darstellung des Einflusses der arabischen Astronomen und Mathematiker, Alchemisten und Aerzte, dass die Probleme, die vor allem in der Geschichte der mittelalterlichen Wissenschaft noch zu lösen sind, nicht gelöst werden können ohne Erschliessung der handschriftlichen arabischen Quellen samt ihrer Verbindung mit der hellenistischen Epoche und deren Ausstrahlungen in den Orient.

Die Anlage des Werkes, das wir hiermit allen empfehlen, die sich in die religiöse Geschichte des Islam vertiefen wollen, bringt es mit sich, dass der Verfasser in seinen Inhaltsangaben mit seiner Persönlichkeit zurücktritt. So wäre es auch eine wenig fördernde Kleinkrämerei, wollte ich an diesem oder jenem Urteil aus eigenem, anders eingestelltem Empfinden Kritik üben oder bemängeln, dass diese und jene Arbeit weggelassen oder vergessen sei. Hätten wir nur noch eine ähnlich aufgebaute Literaturgeschichte der Islamischen Völker und eine Bibliographie der islamischen Wissenschaft, dann könnte endlich gesagt werden, dass das Abendland eine Vorstellung von der welthistorischen Bedeutung des Islam besitzt.

(*Heidelberg*). JULIUS RUSKA.

Immanuel Löw. — Die Flora der Juden. II. *Iridaceae-Papilionaceae*. R Löwit Verlag, Wien und Leipzig. 1924. (Veröffentlichungen der Alexander Kohut Memorial Foundation Band II). XII und 531 S.

Im Jahr 1881 erschien im Verlag von W. Engelmann in Leipzig das Erstlingswerk eines jungen Gelehrten, dem H. L. Fleischer die besondere Empfehlung mit auf den Weg gab, dass ihm seit Chwolsohns Sabiern keine so gelehrte Dissertation vorgelegen habe. Es waren I. Löw's Aramäische Pflanzennamen, jedem Orientalisten vertraut und unentbehrlich, der in die Lage kommt, sich mit der Feststellung der Bedeutung aramäischer, syrischer, aber auch griechischer oder arabischer Pflanzennamen zu befassen. Damals war das Werk 490 Seiten stark und behandelte in alphabetischer Ordnung 339 syrische Pflanzennamen. Heute nach mehr als vierzig Jahren und nach nahezu fünfzigjähriger, einem mühevollen Amte abgerungener Arbeit erscheint das alte klassische Werk in neuer Form, mit vielfach neuem Inhalt, auf drei Bände erweitert, von denen der zweite zuerst herausgegeben wurde und mir zur Besprechung vorliegt.

Die Pflanzennamen sind jetzt nach botanischen Gesichtspunkten, also nach den wissenschaftlichen Namen der Pflanzenfamilien, alphabetisch geordnet, so dass der zweite Band, abgesehen von kleineren Familien, hauptsächlich die Iridaceae, Juglandaceae, Labiatae, Lauraceae, Malvaceae, Myrtaceae, Oleaceae, Palmaceae, Papaveraceae und Papilionaceae umfasst. In welchem Masse dem Verfasser der Stoff unter den Händen gewachsen ist, zeigt die Vergleichung einiger auch schon in der ersten Bearbeitung umfangreichen Artikel mit den jetzt vorliegenden. So ist *Crocus* von 6 auf 18, *Juglans* von 2 auf 35, *Origanum Maru* (Hyssop) von 2 auf 17, der Abschnitt über die *Dattelpalme* von 16 auf 57, über *Baumwolle* von einer halben auf 8 Seiten angewachsen. Dieser Zuwachs ergibt sich selbstverständlich nicht so sehr aus erweiterter lexikographischer Behandlung, als aus kulturgeschichtlichen und sachlichen Exkursen, die in erster Linie aus dem Talmud und verwandter Literatur, aber auch aus alten und modernen Reisebeschreibungen und naturwissenschaftlichen Werken geschöpft sind. So sind aus manchen Abschnitten wahre Kleinodien von liebevoller Versenkung in den Gegenstand geworden, die vergessen lassen, dass man es mit einem Quellenwerk zu tun hat, dessen schwere Rüstung nur wenigen eine fortlaufende Lektüre gestattet, das aber als sicherer Führer durch die verwickelte Gestaltung der Pflanzennamen im Orient unentbehrlich sein und bleiben wird.

Noeldeke und Schweinfurth, den stets bereiten Helfern, ist das Buch gewidmet : der Nestor der Orientalisten und der Nestor der

Botaniker haben das Werk bis zur jetzigen Vollendung begleitet. Da geziemt dem Berichterstatter bescheidene Zurückhaltung, falls er in Einzelheiten etwas zu erinnern fände, rückhaltlose Bewunderung und Dank, wenn er das Mass der nimmermüden Arbeit zu ahnen vermag, das in diesem Werke steckt. Dem greisen Verfasser aber ein herzlicher Glückwunsch, dass es ihm vergönnt war, sein Lebenswerk zu Ende zu führen.

(*Heidelberg*) JULIUS RUSKA.

Henry E. Sigerist. — Studien und Texte zur frühmittelalterlichen Rezeptliteratur. (*Studien zur Geschichte der Medizin*, H. 13). VIII+220 S. Leipzig, J. A. BARTH, 1923.

A long review would be necessary to do full justice to this important publication — a fundamental contribution to our knowledge of medieval medicine. Dr. SIGERIST is a pupil of KARL SUDHOFF; he is now teaching the history of medicine at the University of Zürich and, in all probability, he will some day succeed his master at the head of the Leipzig Institute. The origin of his painstaking investigation of early medieval materia medica was his wish to trace the sources of the Salernitan antidotarium, the so-called *Antidotarium Nicolai*. Let me say at once that the results of his research with regard to this are the following :

The *Antidotarium Nicolai* is probably nothing more than a post-Constantinian revision of an older Salernitan antidotarium, which had already been submitted to Muslim influence. Nothing is known about its author, and it is typical that later Salernitan writers, such as PLATEARIUS and GILLES DE CORBEIL, do not name any. The date generally ascribed, beginning of the XIIth century, may be too late; all that we know is that that revision is post-Constantinian. About half of its recipes can be traced back to CONSTANTINE; about one third can be traced back to ancient or early mediaeval (i. e. pre-Islamic) antidotaria.

SIGERIST has examined many of these early medieval antidotaria and he publishes here for the first time the text of seven of them, to wit : 1. *London antidotarium*. Codex Harleian. 5792 (VII. or VIII. cent.); — 2. *Bamberg antidotarium*. Codex L. III, 6. (IX. cent. or beg. of X.); — 3. *Reichenau antidotarium*. Codex Augiensis CXX (IX.-X. cent.); — 4. *Berlin antidotarium*. Codex Philippicus 1790 (IX.-X. cent.); — 5. *St. Gall antidotarium*. Codex 44 (IX. cent); — 6. *Glasgow antidotarium*. Codex Hunterian. T. 4. 13 (IX.-X. cent.); — 7. *Cambridge antidotarium*. Codex (1567) G. g. V 35 (XI. cent.). Five of these MSS. date of the IX.-X. centuries, while one is a century earlier and another a good century younger; these two are

also much shorter than the others (1). But even if we consider only the five IX.-X. century texts we find that they are o very unequa lengths and very different in many other respects. They are undoubtedly independent publications, though they are based to a large extent upon a common stock of knowledge represented by the materia medica of the VI -VII. centuries. This can be easily checked by comparison with the recipes included in the works of AËTIUS OF AMIDA, ALEXANDER OF TRALLES and PAULUS AEGINETA. As a matter of fact the compilers of those early antidotaria must have made use themselves of Greek originals — or at least these originals were not very remote — as their clumsy transcriptions testify. For example, *cata* (κατά) *sera*, *aceti titartum* (τετάρτη) for *quartarium*, *hos* (ὅς) *datur*, or *melior est e* (ἥ) *pentamiron*! But this Greek scientific tradition was not the only one which led to the creation of the antidotaria; they were also to a certain extent (2) the result of a humbler, more popular tradition, that of the Latin West which can be represented briefly by the following names : PLINY, SCRIBONIUS LARGUS, THEODORUS PRISCIANUS, CASSIUS FELIX, PSEUDO-APULEIUS, SEXTUS PLACITUS, MARCELLUS.

SIGERIST's investigations are important because they give us a new link between ancient times and the Renaissance. Of course, we knew that for obvious reasons medical traditions had never been entirely broken and that, more particularly in South Italy, lay physicians had handed down Greek knowledge from father to son down to the times of Salerno. A new demonstration of the continuity of medical traditions in the early Middle Ages and of their complexity (Greek and Latin, lay and monastic) is nevertheless very welcome and we are indebted SIGERIST for having given it to us.

One more word about the arrangement of the work. An introduction explains the development of materia medica before GALEN and after GALEN and analyzes briefly GALEN's pharmacology. Then follow the seven early antidotaria. Finally, a few studies devoted to them : their form and contents; types of drugs; diseases and their treatment, sources; the Salernitan antidotarium. Elaborate indexes complete fittingly this valuable book.

GEORGE SARTON.

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(1) The Cambridge text is the only one arranged *a capite ad calcem*. All others are arranged in pharmacological order.

(2) This applies more strongly to the Cambridge and Glasgow antidotaria.

Paul Tannery (1843-1904). — Mémoires scientifiques publiés par J. L. HEIBERG. Vol. 5. *Sciences exactes au Moyen Age* (1887-1921). XXVIII + 384 p., 4 pl. Toulouse, EDOUARD PRIVAT, 1922.

L'admirable monument élevé à la mémoire de PAUL TANNERY se complète lentement. Les deux premiers volumes parurent en 1912 (*Isis* I, 114-115, 509-512), les troisième et quatrième en 1915 et 1920 (*Isis* IV, 338-345). Les quatre premiers volumes avaient été édités par J. L. HEIBERG et H. G. ZEUTHEN, mais la mort du dernier en 1920 (*Isis* IV, 171) a interrompu leur longue et féconde collaboration et le cinquième volume ne porte sur sa couverture que le nom de HEIBERG. EMILE PICARD a consacré une biographie à H. G. ZEUTHEN (1839-1920), brève mais forte : il est intéressant de noter que ZEUTHEN fut un disciple de CHASLES de deux manières différentes, en tant que géomètre et en tant qu'historien. Ce n'est que vers 1880 qu'il tourna son activité dans la voie des recherches historiques ; son grand ouvrage sur l'histoire des coniques dans l'antiquité parut en 1884 (traduction allemande, Copenhague 1886).

Il est regrettable que les éditeurs de cette collection persistent à publier les mémoires de chaque volume dans l'ordre de publication, qui est bien artificiel. Conformément à mon habitude, je mentionnerai ici les mémoires contenus dans le vol. 5, d'une manière plus rationnelle, ajoutant quelques brèves remarques :

S. VI.

Les écrits mathématiques de BOÈCE au moyen âge. Article de la *Grande Encyclopédie*, t. 7, p. 28 (p. 348-350) ;

S. IX. ?

Notes sur la Pseudo-Géométrie de BOÈCE. *Bibliotheca Mathematica*, t. 1. 39-50, 1900 (p. 211-228, 1 pl.) « La Pseudo-Géométrie nous apparaît dans un désordre irrémédiable, et nous ne pouvons faire que des conjectures très hasardées sur l'état des sources manuscrites dont elle dérive. Sa forme actuelle peut bien ne pas remonter au delà du IX^e^ siècle. On aperçoit tout au plus qu'elle s'est constituée autour d'un triple noyau dont les éléments étaient peut-être déjà mutilés ou l'ont été à cette occasion : 1° une ancienne version latine d'EUCLIDE, attribuée à BOÈCE, et contenant les démonstrations qui ont été supprimées ; 2° un *liber* arithmético-géométrique, dont il reste les titres des chapitres (leur liste offre cependant des endroits suspects et peut avoir été remaniée après coup) ; 3° un dialogue, l'*Altercatio*, abordant également, avec la géométrie, des questions arithmétiques et métrologiques » . . . . . « Je me figure un manuscrit de la traduction d'EUCLIDE, où l'on avait laissé des blancs pour les démon-

strations, à écrire d'une autre main. Un possesseur du manuscrit se sera servi de ces blancs et des marges pour y inscrire diverses sortes de notes et de fragments intéressant la géométrie ou les pratiques juridiques des agrimenseurs; un autre a pu l'imiter pour l'arithmétique, etc.; il en est résulté un étrange chaos. Au IXe siècle, un copiste a cru y voir un texte entouré d'un commentaire perpétuel et a essayé de remettre le tout en ordre, ce qui était impossible. Voilà la seule idée que je puisse me faire de l'origine de la Pseudo-Géométrie de BOÈCE. Il y des bornes à la stupidité des compilateurs; il n'en est point à celle des copistes ».

S. XI.

La géométrie au XIe siècle. 1° Sur l'invention de la géométrie : « Ceci n'est point un chapitre de l'histoire de la *science*; c'est une étude sur l'*ignorance*, à une époque qui précède immédiatement l'importation en Occident de la mathématique arabe »; 2° Sur l'enseignement au XIe siècle; 3° FRANCON de Liége; 4° RAIMBAUD de Cologne et RAOUL de Liége; 5° GERBERT et les agrimenseurs romains; 6° La géométrie dite de BOÈCE; 7° La géométrie dite de GERBERT, *Revue générale internationale*, t. 2, 1897, 343-357 (p. 79-102).

Une correspondance d'écolâtres du XIe siècle. *Comptes rendus de l'Académie des Inscriptions*, t. 25, 214-221, 1897 (p. 103-111). Mémoire portant le même titre publié avec l'abbé CLERVAL, *Notices et extraits*, 1901, t. 36 (2) 487-543 (p. 229-303). Le texte de cette correspondance latine entre RAGIMBOLD de Cologne et RADOLF de Liége est précédé d'une introduction consacrée à ces écolâtres, aux questions débattues entre eux, au *Geometricum* de BOÈCE, à la *Geometrica* GERBERTI, à FRANCON de Liége et aux quadratures de cercle. Cette correspondance datant de l'an 1025 environ est fort intéressante parce qu'elle montre qu'« à cette époque, en fait de connaissances géométriques véritables, les écolâtres ne dépassaient pas le niveau où pouvaient avoir atteint les Grecs avant Pythagore; autrement dit, que GERBERT n'était nullement parvenu à la fin du Xe siècle, à instituer réellement un enseignement de la géométrie. »

ADALBOLD d'Utrecht. *Intermédiaire des mathématiciens*, t. XI, 1904, 254-255 (p. 352-353).

RAGIMBOLD de Cologne. *Grande Encyclopédie*, t. 28, 90 (p. 350).

S. XII.

Practica Geometriae. Bull. des sciences mathématiques, 1899, t. 23, 140-145 (p. 204-210). A propos de la publication de cet opuscule par MAX. CURTZE en 1897. TANNERY montre que ce texte, datant de la seconde moitié du XIIe siècle, est aussi intitulé *Practica* HUGONIS et cet HUGO est peut-être un HUGO PHYSICUS qui vécut à Paris et mourut en 1199.

« L'intérêt que présentent ces quelques pages pour l'histoire de la Géométrie provient de ce qu'elles marquent un moment singulier de son enseignement. EUCLIDE a déjà été traduit de l'arabe (par ADÉLARD DE BATH), depuis un demi-siècle au moins; mais si notre HUGUES n'ignore plus, comme les écolâtres du XI^e^ siècle, qu'il y a une Géométrie théorique, ce doit être pour lui quelque chose comme, de nos jours, la Géométrie supérieure pour nos instituteurs d'école primaire. Il n'a, de fait, aucune teinture de science gréco-arabe [sauf l'astrolabe !]; il ne sait même pas encore, par exemple, mettre des lettres sur ses figures, pour en désigner les points. Il représente donc la pure tradition latine, à l'instant où son évolution normale, dans notre Occident, va se trouver brusquement déviée par les apports des doctrines orientales. »

Sur la *Practica Geometriae* HUGONIS. *Bibliotheca Mathematica*, t. 2, 1901, 41-44 (p. 308-313).

Practica Geometriae (p. 361-368, 1 pl.). Edition inédite, préparée avec l'aide de FOURRIER-BONNARD, d'un morceau de la *Practica* qui n'est pas inclus dans l'édition de MAX. CURTZE.

Sur le *Liber augmenti et diminutionis* compilé par ABRAHAM. *Bibliotheca Mathematica*, t. 2, 1901, 45-47 (p. 304-7). Il s'agit de l'ouvrage attribué, sans raisons sérieuses, à ABRAHAM IBN EZRA. TANNERY ne résout pas la question.

Sur l'auteur d'un texte algorithmique du XII^e^ siècle publié par CURTZE. *Bibliotheca Mathematica*, t. 5, 1904, 416 (p. 343-345). A propos du texte publié dans les *Abhdl. zur Gesch. der Mathematik*, H. 8, 1898, 3-27 (1) (voir ci-dessous, sous Moyen âge). TANNERY suggère que ADELARD DE BATH pourrait bien être l'auteur de ce texte.

S. XIII.

Magister ROBERTUS ANGLICUS in Montepessulano. *Bibliotheca Mathematica*, 1897, 3-6 (p. 112-117).

Le Traité du Quadrant de Maître ROBERT ANGLES. Texte latin et ancienne traduction grecque. Appendice sur le Traité de l'astrolabe universel ou Saphea d'ARZACHIEL par GUILLAUME l'ANGLAIS. *Notices et extraits*, 1897, t. 35 (2), 561-640 (p. 118-197).

Le Traité du Quadrant. *Bull. des sciences mathématiques*, t. 23, 1899, 145-50 (p. 198-203).

S. XIV.

Ouvrage mathématique de DOMINICUS DE CLAVASIO, p. 357.

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(1) Et non 17-37.

S. XV

L'extraction des racines carrées d'après NICOLAS CHUQUET. *Bibliotheca Mathematica*, 1887. 17-21 (p. 1-7).

S. XIX.

MAXIMILIEN CURTZE [1837-1903], *Journal des Savants*, 1904, 457-470 (p. 322-342). Etude fouillée de l'œuvre du grand historien des mathématiques médiévales.

Moyen Age.

Préface à l'Histoire de l'abbaye royale et de l'ordre des chanoines réguliers de Saint-Victor de Paris, par M. FOURIER-BONNARD, vol. 1. Paris 1903 (p. 314-321).

Sur la division du temps en instants au moyen âge *Bibliotheca Mathematica*, t. 6, 1905, 111 (p. 346-347). A propos d'une division indiquée dans un traité algorithmique du XII^e^ siècle publié par CURTZE (voir plus haut). L'heure est divisée en 40 parties (*momenta*); chaque *momentum* en 564 parties. L'heure est donc divisée en 22,560 *instantia* ou *atomi*. L'explication de cette division extraordinaire est la suivante : « $564 = 12 \times 47$. D'autre part, $235 = 5 \times 47$, et 235 est le nombre des mois du cycle de MÉTON. On a donc cherché à établir une commune mesure entre l'année julienne et le mois lunaire de façon à pouvoir les exprimer l'une et l'autre par des nombres entiers et faciliter ainsi le calcul des jours de la lune. Il fallait pour cela introduire dans la subdivision de l'heure le facteur 47. On l'a fait d'ailleurs en le multipliant suffisamment par les facteurs simples pour arriver à un intervalle assez petit (au-dessous d'un sixième de nos secondes) pour pouvoir être regardé comme indivisible. L'opinion que le temps est composé d'éléments indivisibles semble avoir été transmise au moyen âge par MARTIANUS CAPELLA (IX. § 97); elle est expressément professée par ISIDORE DE SEVILLE, puis par BÈDE le Vénérable, auquel seulement paraît remonter la détermination précise du nombre des atomes de l'heure. Après lui, elle est relativement fréquente, et le mot d'atome est resté en italien, sous la forme *attimo*, pour désigner un instant.

Rome.

Un nouveau texte des Traités d'arpentage et de géométrie d'EPAPHRODITUS et de VITRUVIUS RUFUS. *Notices et extraits*, 1896, t. 35 (2), 511-50 (p. 29-78, 2 pl.).

Mathématiques.

Les prétendues notations pythagoriciennes sur l'origine de nos chiffres. *Revue archéologique*, 1892, t. 20, 54-65 (p. 8-21).

Sur l'étymologie du mot chiffre. *Ibidem*, 1894, t 23, 48-53 (p. 22-28).

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Cette énumération beaucoup trop brève, car j'aurais voulu pouvoir parler plus longuement de chaque article, et cependant si longue, prouve assez la richesse de ce cinquième volume. Mais quiconque se donnera la peine de l'examiner se convaincra que l'ordre de publication de ces mémoires est tout à fait mauvais. Ainsi les trois mémoires relatifs à la *Practica* HUGONIS se trouvent, non pas ensemble, mais à trois endroits différents du livre ! L'ordre chronologique est fort bien quand il s'agit de mémoires relatifs à un même sujet, mais s'il conduit à mêler tous les sujets sans aucun ordre, il devient détestable.

Je dois remarquer aussi, à mon grand regret, qu'il n'y a aucune trace de travail de l'éditeur dans cette collection. Plusieurs questions traitées étaient en litige; depuis que TANNERY s'en est occupé plus de trente ans se sont écoulés Des travaux importants ont paru depuis. Il eût valu la peine de les indiquer en note et cela eût augmenté considérablement la valeur de cette publication. A vrai dire, il eut fallu pour cela la confier à un autre spécialiste, car il est clair que le savant Danois qui a bien voulu s'en charger n'est pas au courant des travaux relatifs aux mathématiques médiévales. Mais en dehors de cela, un éditeur consciencieux aurait tâché de donner en note quelques brèves indications absolument nécessaires : ainsi à la page 204, il aurait fallu nous dire de quel opuscule de M. CURTZE il s'agit. Il est vrai que nous le découvrons par hasard à la page 361, mais cela ne suffit point. Quelques courts articles sont des réponses à des questions ; il aurait fallu nous résumer les questions elles-mêmes. Dans un cas j'ai été obligé de relire la question dans *Bibliotheca Mathematica* pour bien saisir la portée de la réponse, et ma foi, dans ce cas, j'aurais pu aussi bien lire la réponse elle même dans le même recueil. Mais j'en ai dit assez pour prouver que cette édition des œuvres de TANNERY n'est pas aussi soignée qu'elle le devrait ni qu'elle le paraît, Je me permets de formuler l'espoir que les volumes suivants seront plus satisfaisants à ce point de vue En tout cas, nous devons être reconnaissants à M^me^ TANNERY de mettre ainsi à notre disposition, sous une forme si commode, les trésors d'érudition légués par son mari.

GEORGE SARTON.

Vialleton, Louis. — *Morphologie générale; Membres et ceintures des vertébrés tétrapodes; Critique morphologique du transformisme.* VIII + 710 p. gr. in-8°, 270 fig. GASTON DOIN, Paris, 1923. [60 fr.]

Ce très important ouvrage semble marquer le terme de l'évolution de la pensée de son auteur qui, parti de la critique du transformisme haeckélien (*Un problème de l'évolution*, 1908), en vient à se séparer des tenants de la doctrine classique, ce changement d'attitude étant appuyé

sur une base anatomique qui semble extrêmement solide. Et le livre de VIALLETON me paraît ainsi être non seulement un monument anatomique précieux prolongeant ses *Eléments de Morphologie des vertébrés* (1911), mais devoir marquer une date dans l'histoire des théories de l'évolution, précisément en raison de la notoriété de l'auteur parmi les anatomistes.

L'ouvrage est divisé en trois parties dont les deux premières constituent la base anatomique d'où sont tirées les conclusions. Il peut sembler à première vue qu'il y ait disproportion entre l'ampleur de celles-ci et l'importance de l'objet des deux premières parties : Constitution anatomique des membres et des ceintures (pp. 1-480), valeur morphologique et homologies des ceintures et des membres (pp. 481-535), mais outre que la comparaison des membres et des ceintures et la recherche de leur origine sont un des problèmes les plus difficiles de la morphologie des vertébrés, leur importance grandit singulièrement quand on les envisage, comme c'est le cas ici, dans leurs rapports avec l'ensemble de l'organisme.

Dans la première partie, l'auteur étudie les types principaux de l'appareil locomoteur chez les amphibiens, les reptiles actuels et fossiles, les oiseaux et les mammifères. Cet ensemble, surtout descriptif et dans lequel un article est consacré à l'homme, « type extrêmement particulier dont l'éloignement des autres formes mammaliennes est beaucoup plus considérable qu'on ne le pensait il y a quelques années » (p. 430), est suivi d'un chapitre sur le développement morphologique et histologique des membres. (VIALLETON, depuis sa thèse sur les premières phases du développement de la seiche (1888), n'a jamais abandonné complètement les travaux d'histologie.)

Cette base anatomique étant acquise, le savant professeur de Montpellier examine dans la seconde partie la question de la signification morphologique des membres, et c'est pour lui l'occasion d'exposer et de critiquer les théories de GEGENBAUR, DOHRN, BALFOUR, MIVART, TEACHER, GEDDES, puis celle de Ch. MARTINS (torsion), la théorie de la rotation, la théorie de STIEDA, les théories antitropistes (VICQ D'AZYR, FOLTZ, EISLER, GEDDES), toutes celles-ci relatives à la comparaison des membres antérieur et postérieur. VIALLETON conclut que les membres et ceintures des vertébrés ne proviennent pas d'une forme initiale unique, placée à l'origine des tétrapodes actuels auxquels ils se seraient transmis par héritage, mais que « leurs ressemblances tiennent simplement à ce qu'ils remplissent tous les mêmes fonctions dans des organismes d'un même type, et sont soumis à des conditions identiques » (p. 534), et revient à la conception de CUVIER « qui cherchait dans l'organisme lui-même, considéré comme un système unique et clos, la véritable loi de sa formation » (p. VI).

La troisième partie s'ouvre par cette phrase qui montre on ne peut plus nettement la position que ses études anatomiques amènent VIALLETON à prendre vis-à-vis du transformisme : « Le transformisme classique expliquant les différents types animaux par des transformations lentes, graduelles, opérées petit à petit chez des êtres vivant d'une vie libre, se montre absolument inadmissible lorsqu'on examine d'un peu près la constitution des parties et l'importance des changements qu'il aurait fallu y apporter pour passer d'un type à un autre. » Dans l'impossibilité de signaler toutes les difficultés qu'a fait naître la morphologie dans ce domaine, il en examine un certain nombre qu'il groupe dans trois chapitres distincts suivant qu'elles se rapportent principalement à l'embryologie (l'examen de ce point particulier faisait presque à lui seul l'objet de *Un problème de l'évolution*, bien que l'auteur n'y eût pas pris la position qu'il adopte aujourd'hui), à l'anatomie comparée et à la systématique. Dans le chapitre traitant de l'anatomie comparée, il signale en particulier un certain nombre d'erreurs graves commises par quelques auteurs de reconstitutions d'êtres disparus : entre autres, dans la figuration de l'Archaeopteryx de STEINMANN-DÖDERLEIN, de LULL, dans celle du Proavis de NOPSCA, etc.

Quelle est donc la conclusion générale ? Elle est toute de réserve, d'attente dans les résultats que donnera la morphologie dont on médit si fort dans certains milieux de biologistes. « La science ne possède pas encore la clef des énigmes de l'univers, quoi qu'en ait pensé HAECKEL. C'est pourquoi, au lieu de se laisser entraîner par l'engouement général, si mal étayé sur un anthropomorphisme grossier et sur une science insuffisante..., il faut édifier une anatomie très exacte, tenant compte de tout, et non seulement de ce qui vient à l'appui d'une explication préconçue... il faut chercher à comprendre les multiples conditions auxquelles répondent les organes, et ne pas s'en laisser imposer par de simples convergences ».

Il appartient aux anatomistes de discuter les détails morphologiques sur quoi s'appuie la critique de VIALLETON. Mais ils devront rendre hommage au souffle de sincérité qui anime toute l'œuvre, et à l'effort de saine compréhension philosophique qu'elle représente, quelle que soit leur attitude vis-à-vis du problème général qui fait le fond du débat.

L. GUINET.

F. de Montessus de Ballore (1851-1923). — *Ethnographie sismique et volcanique*, ou les tremblements de terre et les volcans dans la religion, la morale, la mythologie et le folklore de tous les peuples, VIII + 206 p. in-8°. ED. CHAMPION, Paris, 1923. [20 fr.]

Alors qu'il accumulait les documents de sa *Bibliografia general de tremblores y terremotos* (8 vol. in-8°, Santiago, 1915-1919), l'attention du

regretté Directeur du service sismologique du Chili fut attirée par le grand nombre des croyances populaires et mythologiques relatives aux tremblements de terre et aux volcans, et il en entreprit une recherche systématique Ce sont les résultats de cette recherche, poursuivie sans autre but que de fournir un instrument de travail, qui font l'objet de ce livre, dont l'auteur n'a pu corriger les dernières épreuves.

La matière est partagée en trois parties : *a*). Les sciences travesties. L'auteur a groupé sous ce titre « une série d'opinions ou même de théories que les efforts de la science moderne des tremblements de terre n'ont pas encore réussi à extirper des préoccupations des savants. Ce sont des relations supposées des tremblements de terre avec une foule de phénomènes extérieurs à l'écorce terrestre, météorologiques, cosmiques ou autres » ; *b*). L'animisme : est ici groupé ce qui a rapport à la zoologie sismologique, aux mânes, à la mythologie sismologique, à la mythologie volcanique, à la démonologie sismologique et volcanique, à l'anthropologie sismique ou volcanique ; *c*). La troisième partie contient ce qui a trait aux croyances et pratiques religieuses et superstitieuses, prodiges et miracles, présages et prédictions.

C'est là le premier essai d'inventaire des opinions relatives aux convulsions sismiques ou volcaniques. La classification en était extrêmement difficile, et on pourrait en imaginer facilement d'autres que celle qu'a adoptée MONTESSUS DE BALLORE ; ce ne peut être le travail que des professionnels du folklore. Mais la difficulté se trouve ici corrigée par l'existence de trois index qui permettent de suivre chacun des genres de croyances, d'en étudier l'évolution historique ou l'extension géographique et ethnographique, et faciliteront l'usage de ce livre un peu touffu.

L'auteur s'est défendu de tirer de cette foule de croyances incohérentes des conclusions anthropologiques ou philosophiques. Il attire cependant dans les termes suivants l'attention sur un résultat de haute portée, confirmé par une multitude d'autres observations concordantes :

« On verra que les croyances populaires sismiques ou volcaniques, même celles qui nous semblent les plus étranges, ne sont presque jamais l'apanage d'un seul peuple, car on les rencontre disséminées sur toute la surface du globe et dans des circonstances de temps et de lieu qui excluent toute possibilité de transmission de proche en proche ou par des émigrations. Ainsi l'accouchement de la lune en liaison avec des tremblements de terre se rencontre en Bolivie et aux Moluques, les volcans sont mari et femme au Japon comme en Amérique, et beaucoup d'autres thèmes tout aussi bizarres se présentent sporadiquement. Par contre, certaines croyances se retrouvent sur toute la surface du globe, ainsi les mânes ou les animaux déchaînent les commotions terrestres,

ou l'idée que ces phénomènes sont des châtiments infligés par des puissances supérieures. Tout cela confirme une fois de plus l'unité de la mentalité humaine et cela depuis les temps les plus reculés. »

L. GUINET.

Ernst Cassirer. — *Substance and Function and Einstein's Theory of Relativity*. Authorized translation by WILLIAM C. and MARIE C. SWABEY. Chicago-London, The Open Court Publishing Co., 1923. XII and 465 pages.

Professor CASSIRER has produced in the present volume a work deserving the closest study on the part of logicians, natural scientists, and philosophers. The book consists of three parts — a logical discussion of the concepts of thing and relation; a metaphysical treatment of relational concepts and the problem of reality; and an epistemological examination of the theory of relativity.

In Part One, the author tries to vindicate the attempt of modern logic to replace the Aristotelian logic of substance by a logic of relations. With a remarkable wealth of detail, CASSIRER aims to demonstrate the incomparable superiority of relation-logic over thing-logic in our understanding of the fundamental concepts of arithmetic, geometry, physics, chemistry, and, in general, the basic concepts of all natural science. No recent discussion seems to escape our author. FREGE's and DEDEKIND's foundations of arithmetic; CANTOR's cardinal and ordinal transfinites; RUSSELL's struggles with the elusive notion of class; space and order; metric and projective geometry; metageometries; geometry from the standpoints of intuition and analysis, and of rationalism and empiricism; time and motion; the Pearsonian doctrine of « limiting concepts » in science; NEWTON, BOSCOVICH, DUHEM; energetics; atomic theory; the mathematics of chemistry — these and hosts of other developments contribute to the proof of one of Professor CASSIRER's theses. The thesis is, that thing-logic has been tried and found decisively wanting, and that relation-logic is its triumphant successor.

To the reviewer it seems that the author would have made his impressive accumulation of arguments still more nearly conclusive had he shown, in some detail, how mathematical logic has rendered thing-logic not so much useless as meaningless. True, CASSIRER does refer to HILBERT's postulates for geometry. But the central rôle of postulational technique — particularly its insistence on the *structural*, as opposed to the interpretational, aspects of postulational determinations of systems; in the other words, its insistence on the distinction between « systems » and « system functions » — does not seem to be sufficiently emphasized in the course of the proof of CASSIRER's first thesis.

What we are calling the first thesis — the inevitability of relation-logic — is intertwined throughout the book with what we may refer to as the second thesis, namely, that relation-logic demonstrates that critical idealism, at least a certain refined form of critical idealism, constitutes the only true philosophy of natural science. This second thesis is elaborated especially in Part Two. In illuminating chapters on the problem of induction, on the concept of reality, on the subjectivity and objectivity of relational concepts, and on the psychology of relations — chapters of particular interest to philosophers — the author makes strenuous efforts to render the second thesis as inescapable as the first. In fact, CASSIRER would oppose our dichotomy. He would insist that he was dealing not with two issues, but with one. However this may be — whether we regard the argument as involving two distinct theses, or one thesis with two distinct phases — from the very nature of philosophic disputation we cannot assert that the case for critical idealism has been made more than plausible.

The same double thesis is maintained by the arguments of Part Three, which the translators call the Supplement. In this part, entitled EINSTEIN'S theory of Relativity considered from the epistemological standpoint, CASSIRER examines those problems that one would naturally associate with a philosophic survey of scientific relativity — the concept of measure; the empirical and the conceptual foundations of relativity; matter, ether, and space; euclidean and non-euclidean geometry; truth and relativity; critical idealism and relativity; relativity and reality. Once more we find the first thesis defended, brilliantly and successfully. Indeed, it is difficult to see how a thorough comprehension of the logic of Einsteinian relativity can be obtained otherwise than relationally. The Supplement closes with a carefully chosen bibliography of 84 books on relativity. (WHITEHEAD'S contributions to the reconstruction of the philosophy of relativity are not mentioned.)

Parts One and Two of the present translation appeared in 1910, under the title, *Substanzbegriff und Funktionsbegriff;* the Supplement, published in 1921, is called *Zur* EINSTEIN'*schen Relativitätstheorie.* These two books are of the highest importance to the logician and the logically-minded scientist. By presenting them in one volume in a clear, correct, and readable English form, the translators have rendered a service to philosophy.

(Harvard University.) HENRY M. SHEFFER.

David Eugene Smith. — *History of Mathematics.* Volume 1. General survey of the history of elementary mathematics. XXII+596 p., many illustrations, Boston, GINN, 1923.

The students of the history of mathematics owe already to Prof. SMITH three works of great importance : (1) *Rara Arithmetica.*

A catalogue of the arithmetics written before the year 1601 with a description of those in the library of GEORGE ARTHUR PLIMPTON of New York. XVI + 507 p. Boston, GINN, 1908; (2). *The Hindu-Arabic Numerals* (with L. C. KARPINSKI) VI + 160 p. Boston, GINN, 1911; (3). *A History of Japanese Mathematics* (with YOSHIO MIKAMI). VIII + 288 p. Chicago, Open Court, 1914. The first two appeared before the foundation of *Isis*, the third was fully reviewed by A. REYMOND in vol. 2, 410-3. A complete list of D. E. SMITH's contributions to the history of mathematics would be very long. I have quoted the three most important; I should still mention among his latest publications the three following : *The Sumario Compendioso of Brother* JUAN DIEZ. The earliest mathematical work of the New World (Mexico, 1556). Boston, 1921 (*Isis*, IV, 409); Computing jetons. New York, 1921 (*Isis*, V, 553); and, Mathematics. (Our debt to Greece and Rome.) Boston, 1923 (*Isis*, VI, 188).

The work under review is of a more popular kind than those already mentioned : « it has been written for the purpose of supplying teachers and students with a usable textbook on the history of elementary mathematics, that is, of mathematics through the first steps in the calculus ». As a general policy, I avoid reviewing at length elementary textbooks on the history of science and I believe it sufficient to devote to them a shorter note in the Critical Bibliography, but I must make an exception in favor of SMITH's History for two reasons. The first is that it is really based on a large amount of patient and original investigation; the second, that it is essentially different from previous works bearing the same title.

I wish to develop the first reason a little more. Because of my insistence on the fundamental value of pure, sound and deep scholarship and my hatred of every form of pseudo-scholarship, some people have concluded that I was opposed to and looked down upon every kind of popular work. Nonsense ! For one thing I realize very deeply that the discovery of truth and its diffusion, when it is found, are two complementary tasks. It can not be said that one is more important than the other, for neither is sufficient and both are necessary. I am so far from disdaining popular work that I consider it almost the duty of every scholar to devote at least one part of his energy, towards the end of his life, to such work. A scholar who can draw upon the accumulated and selected experience of a long life is more likely to know well that which is most important in a work of that kind : the relative value of facts and theories, the deeper meaning of events, the true signification of great men. On the other hand, I am very suspicious of, and impatient with, popular works written by men whose own knowledge is too fresh to be deep and too artificial, too little their own, indeed, to be worth diffusing. My main

contention is that one's knowledge becomes valuable only when it has been completely assimilated and when, by a long process of comparison and selection, its various elements have found their proper places. This takes time. Popular works written by younger men may enjoy more popularity for those whose knowledge is very new know better what will appeal to ignorants, but the immediate success of a work is no measure of its value and does not interest me.

I said that SMITH's history is essentially different from previous ones. This is easy to prove. In the first place, it is divided into two parts, each forming one volume. The first is an outline of the growth of mathematics in chronological order with due consideration to racial achievements; the second, a discussion of the evolution of certain important topics. That is, if the whole of mathematics was compared to a tree, the first volume is devoted to a history of that tree, the whole tree, at its different ages; the second volume, to the study of particular branches. This is a very ingenious way of solving the greatest difficulty in any similar undertaking : how to reconcile the technical element with the personal and racial elements. The main purpose of a history of mathematics is naturally to explain the development of mathematics; yet this development can not be divested from its human aspect, nor is it at all desirable that it should. I must say that I prefer CANTOR'S method of telling both stories, the abstract and the human, at once, but this is exceedingly difficult and I admit that SMITH'S method is far superior from the pedagogical point of view.

A full criticism of SMITH'S work must be suspended until the second volume has appeared, for both volumes complete one another to a much higher degree than the volumes of a single work generally do. These two volumes, indeed, are meant to be read and used simultaneously and not successively. I imagine that the boys and girls using them will study the second volume under compulsion, but will read the first one with more spontaneity and thus with more pleasure. The author has taken considerable pains to whet their appetite and to gratify their curiosity. This leads me to the consideration of the second distinctive feature of this history : the abundant illustrations which embellish it and which put life and zest into it. It will be truly a great pleasure to teach or be taught from such a book.

A third distinction of SMITH'S history is the large amount of space devoted to Oriental mathematics. I consider this a capital improvement. This part of the work has gained more that any other by the addition of illustrations, for it is not possible in any other way to give students some concrete idea of Arabic, Hindu or Chinese mathematics. Each illustration will be a peg in their memories upon which to hang whatever knowledge they may retain.

This first volume is divided into ten sections as follows : 1. Pre-

historic mathematics (19 p.); 2. Historic period down to 1,000 B. C. (35 p.); 3. Period from 1,000 B. C. to 300 B. C. (48 p.); 4. From 300 B. C. to 500 A. D. (46 p.); 5. From 500 to 1,000 (46 p.); 6. The Occident from 1,000 to 1,500 (72 p.; this section includes Oriental, *i. e.*, Muslim and Jewish, work done in the West, an arrangement open to question); 7. The Orient from 1,000 to 1,500 (26 p.); 8. The XVI. century (66 p.); 9. The XVII. century (86 p.); 10. The XVIII. century and after (105 p.). This subdivision of the subject seems very good, save that I have some doubts as to the advisability of breaking the account of Muslim science, from 1,000 to 1,500, into two. The relative proportions of these parts strike me, too, as very happy.

The two most difficult parts of a history of science to deal with, are first the Oriental developments and second the more recent, say, the XIX. century, developments. The author has dealt with the Oriental part of his history in a very remarkable way. In fact his solution of that difficulty is a new departure of considerable value, which will entirely modify the teaching of the history of science, as soon as it is thoroughly appreciated. His handling of modern science is, in my opinion, less satisfactory, though for this part even more than for the others, judgment must be held in abeyance until the publication of the second volume. The information given on modern mathematicians is a little meager and often vague and meaningless. Moreover the division by countries becomes here a little irritating, for it entirely destroys the chronological sequence. The author forgot that these two latest centuries, because of their proximity and of their richness, must be dealt with in a different way than the other periods. It may suffice to remember that HERMANN THE LAME flourished in the XI. century, but it does not suffice to remember that GAUSS and POINCARÉ flourished in the XIXth. — for there is more difference between the beginning and the end of that century than there was between the X. and the XV. century. Thus, to be able to apply his geographical treatment successfully to the end, SMITH should have divided his last section into at least three subsections: XVIII. century, first and second halves of the XIX. century.

The illustrations are very well chosen and very attractive. There are many facsimiles of title-pages and manuscripts (Western and Eastern), reproductions of ancient instruments and a good collection of portraits (including the recently discovered portrait of RECORDE; see *Isis*, V, 226). However, the inclusion of fanciful portraits (for ex., of PLATO and FINOBACCI) seems to me a serious mistake for which I can find no justification. A splendid idea was the introduction of maps (p. 60, 154) showing the places of mathematical interest in the Mediterranean countries of classical times and in India. That is capital. It is a pity that the present state of knowledge does not make it possible to draw a similar map to illustrate the development of Chinese mathematics. By adding these maps, the author stole a march upon me for I have

been thinking for a long time of introducing such maps into my *Introduction* to show at a glance the geographical distribution of scientific work in each century. However, I do not regret this, for SMITH's maps have given me many hints which will not be lost !

This original textbook is happily completed by six pages devoted to the historians of mathematics. Again an excellent idea, but it would have been better, I believe, to make of the sub-section a separate section and the more so because it takes us back into the XVII. century with JOHN WALLIS and even into the XVI. century with BERNARDINO BALDI. These pages are adorned with a portrait and autograph of MONTUCLA. Finally, there is a chronological table, which, brief as it is (22 p.), will prove very useful.

GEORGE SARTON.

Felix Auerbach. — *Entwicklungsgeschichte der modernen Physik, zugleich eine Uebersicht ihrer Tatsachen, Gesetze und Theorien*, VIII+344 S., 115 Abbild, JULIUS SPRINGER. 1923.

Modern physics is one of the hugest, and perhaps the most complicated scientific subject of our time. Therefore a work of three hundred pages, purporting to deal with the evolution and present state of modern physics, cannot be more than the author claims his work to be — a bird's-eye view of the more outstanding parts. The author accomplished his purpose, and achieves a certain comprehensiveness withal, by casting his book in a highly ingenious form, which is, indeed, the most noteworthy feature of the book. The book is divided into two distinct parts, of which the first is a « general » part, the second, a « special ».

The first chapter of the first division deals with the nature of physics, its general methods of thought, and the concepts which lie at the bottom of it, *i. e.* space, time, matter and energy. The theory of relativity is not introduced at this point, but the ideas of classical mechanics, and the two laws of thermodynamics, are treated in a general, historical-expository manner. The second chapter, on the constitution of matter, gives a brief account of how the kinetic-atomic theories of physics, together with the stoichiometric-atomic theory of chemistry, have been fused by the epoch making recent discoveries in physics and physical chemistry into a great solid body of positive knowledge about the constitution of matter. These first two chapters are of an introductory nature. The real exposition begins with the third chapter, on vibratory motion. This naturally leads to the subject of wave motion, and thus to the field theories of electricity, magnetism, light, and gravitation, which are treated in the fourth chapter. The transition to the subjects of conduction and radiation, dealt with in the fifth and sixth chapters, respectively, is obvious and logical. The

seventh chapter deals more closely with radiation, and contains an excellent account of the evolution of the quantum theory, showing how the facts of blackbody radiation, by flat contradiction of that corner stone of the classical system, the MAXWELL-BOLTZMANN theorem of the equipartition of energy, forced a quantum theory, itself a contradiction of the classical theory, to arise. And then, naturally enough, the eighth chapter treats of the greatest triumph of the quantum theory : its revelation of the relations between atomic structure and spectral lines — the epoch making achievement of BOHR. The ninth chapter is in the nature of an interpolation. It deals with the state of material systems as a function of such variables as pressure, temperature, and volume, and encompasses such varied subjects as the theory of VAN DER WAALS, the phase rule of GIBBS, and the definition and measurement of temperature. The tenth and last chapter of the general division deals with the theory of relativity. The account of the decline and fall of the ether is noteworthy, and the material on the special theory is fairly comprehensive. It was of course impossible to set forth anything more about the general theory or relativity than the necessity for its existence and the various confirmations of it. In the reading of the general part, one receives a very good idea of the four great branches of modern physics : the electron theory, the quantum theory, the theory of the nucleus atom, and the theory of relativity. Of these the author says, in summing up, that « each has its own proper region, in which it holds and is fruitful; but each reaches out beyond its own region, and finaliy all four interpenetrate more or less ». The author makes this interpenetration, which is the significant fact of modern physics, very clear.

The second, « special », division of the book comprises seven chapters, which more or less coincide with the old « systematic » division of physics into mechanics, sound, heat, light, electricity, and magnetism. The first chapter is on the classical mechanics of rigid bodies; the second, on that of elastic solids; the third, on that of fluids. The fourth chapter treats of sound; the fifth, of heat; the sixth, of electricity and magnetism; the seventh, of light. These chapters are necessarily of a summary nature. And precisely for that reason are they valuable to historians of science and to scientists, on account of the detail of reference given in the subjects taken up. The second part furthermore binds together and gives solidity to the first.

The book is on the whole more expository than historical. As each subject is taken up, a historical sketch is given : that is, the names and dates of the scientists who have contributed to our knowledge of that particular subject are reviewed. But it is not real history. The bulk of the emphasis is always on the explanation of the present of affairs. On the other hand, the reading of the book does give a good general idea of the evolu-

tion of the science as a whole : one understands the interdependence of the various parts. And in spite of the necessarily topical manner of treatment, one always retains a sense of proportion and continuity. Whenever the author leaves out a big part, he takes pains to say so, and generally conveys an idea of its size, importance, and position in the general structure.

The appendix of the book consists of two lists. The first is a chronological one of the more important events in the history of physics, together with the names associated with them, from the work of EMPEDOCLES to that of BOHR. The second list is that of the great deceased physicists with their dates. The lists are quite complete and very convenient for reference.

On the whole, it is a book which will be very interesting, both to historians of science, and to scientists.

(*Munich.*) F. OTTO KOENIG, Jr.

Der Jenenser Physiker AUERBACH ist in weiteren Kreisen bekannt durch seine « Physik in graphischen Darstellungen », einem Werke, in dem zum ersten Male die graphische Darstellung als ausschiessliche Form gewählt und versucht worden ist, das ganze Gebiet mit ihr zu umspannen, (Leipzig, 1912, TEUBNER). Auch durch seine Geschichtstafeln der Physik (Leipzig, J. A. BARTH, 1910) hat sich AUERBACH um die physikalische Lehrbuchliteratur verdient gemacht.

Das oben angezeigte Werk ist aus Vorlesungen hervorgegangen, die sein Verfasser in regelmässigen Zwischenräumen an der Universität in Jena gehalten hat. Bekanntlich bilden Vorlesungen über ein geschichtliches Gebiet der Naturwissenschaften an den deutschen Universitäten immer noch eine Ausnahme, während sie im englichen Sprachbereich häufiger auftreten und neuerdings, wie in London, durch eine allgemeine, bis etwa 1800 reichende, geschichtliche Einführung in das Gesamtgebiet der Naturwissenschaften ergänzt werden.

AUERBACH betitelt sein Werk « Entwicklungsgeschichte der modernen Physik », und doch verwahrt er sich im Vorwort dagegen, dass er nur von ferne an eine Geschichte der Physik gedacht habe. Es klingt das etwas paradox. Darüber hilft auch die Erklärung nicht hinweg, dass der Nachdruck auf der Idee der Entwicklung liege und zwar immer im Hinblick auf den gegenwärtigen Stand. Allerdings bringt AUERBACH keine chronologische Darstellung. Aber auch, wo diese bevorzugt wird, sollte man doch stets darauf abzielen, durch das Gebotene in die Probleme der Jetztzeit einzuführen. Was AUERBACH schliesslich bringt, ist eine innerlich verknüpfte und insofern entwickelnde Uebersicht über eine Anzahl wichtiger Tatsachen, Gesetze und Theorien der Physik. Sie betreffen folgende Gebiete : Die Konstitution der Materie, Bewegung, insbesondere Schwingungsbewegung, Wellenbewegung, Fernwirkung und Feldtheorie, Leitung,

Strahlung, Spektrum und Materie, Zustandslehre, Relativitätstheorie.

In einem speziellen Teil werden die Prinzipien der Mechanik, der Schall, die Wärme, Elektrizität, Magnetismus und das Licht behandelt. Im Schlussabschnitt finden sich zwei Tabellen rein historischer Art, nämlich eine Auswahl wichtiger Fortschritte, ihrer Urheber und Jahreszahlen und eine Auswahl hervorragender verstorbener Physiker mit Geburts- und Todesjahr.

Wird in dem Buche die Darstellung der älteren Forschung auch nicht ganz ignoriert, so beschränkt sie sich doch in der Hauptsache auf die Zeit seit etwa 1800. Zur Erläuterung des Textes benutzt der Verfasser mit Vorliebe die graphische Darstellung. Es geht das soweit, dass er mitunter auch die Geschichte einer Konstante in dieser Form bringt, z. B. in Abbildung 1 das « Wärmeäquivalent in historischer Darstellung » oder in Abb. 42 « Die Geschichte der Bestimmungen von e/m. »

Am eingehensten sind in dem allgemeinen Teile die Zustandslehre und die Relativitätslehre behandelt. Das Buch ist geeignet, eine Ergänzung der grösseren Lehrbücher der theoretischen Physik zu bilden.

(*Bonn.*) F. DANNEMANN.

Lafayette B. Mendel. — Nutrition : *The Chemistry of Life*, 150 p., New Haven, Yale University Press, 1923. [$ 3.00]

The attention of students of nutrition has, of late years, been largely directed to the « accessory food factors », or vitamines. Following the demonstration by TAKAGI KANEHIRO in 1884 that beriberi, a peripheral polyneuritis resulting in paralysis, was due to a faulty diet, EIJKMAN in 1897 showed that there was something in the bran layer of rice which protected against the disease. This substance came to be known as « Water soluble B » vitamine. In 1912 HOLST and FRÖELICH initiated the modern knowledge of the etiology of scurvy by showing that guinea pigs readily develop the disease when confined to a diet of cereals or of bread. The vitamine lacking in this instance is « Water soluble C ». STEPP in 1909 fed mice on lipin-free diets; they died within thirty days. MC COLLUM and DAVIS in 1913, and OSBORNE and MENDEL later in the same year showed that certain fats contained something which greatly promoted growth. This « Fat soluble A » vitamine was also shown to prevent xerophthalmia, an inflammation of the eyes.

It furthermore appears from the work of VOETGLIN in 1920 that pellagra may be a specific disease. Rickets likewise, as shown largely by the researches of MC COLLUM and his co-workers (1921), seems to be associated in part with the lack of an anti-rachitic

organic substance. Finally EVANS and BISHOP in 1922 have pointed to the existence of a dietary factor essential for reproduction (placentation) of rats.

Due to the importance of these recently discovered factors in nutrition, it is of great interest to have a general summary of the present knowledge in the field of nutrition. MENDEL, in this volume, begins by a historical outline of the successive theories.

As early as the time of HIPPOCRATES (460-370 B. C.) there existed a belief in the occurrence of some specific universal nutrient substance. With the beginning of biochemistry this belief was dispelled, and we see the earlier development of the classification of foodstuffs in vogue to-day. THUS WILLIAM PROUT (1785-1850) considered that all organized bodies are constitued of three great staminal principles : saccharina, oleosa, albuminosa.

MAGENDIE (1783-1855) demonstrated the unlike values of these three foremost groups, recognizing the relative importance of the nitrogenous foods. G. J. MULDER (1802-1880) coined the word « protein » in 1839, and saw the resemblance of albuminous substances in animals and plants. LIEBIG (1803-1873) believed in the dominant importance of proteins, while minimising the value of the other nutritive groups. Largely under the leadership of CARL VOIT (1831-1908) the energy aspects of nutrition became recognized, as well as the interchangeability of the organic foodstuffs.

The latter part of the book deals with modern researches. Attention is called to the « little things » in nutrition, such as phosphorus, calcium, and iodine. The author summarises in a general way the knowledge of the vitamines, relating his own discoveries in this field. The chemical nature of these substances is not discussed, but much attention is paid to their physiological significance.

It is pointed out that the normal physiology of proteins has largely become a question of the behavior of the amino-acids in nutrition. Certain of these are indispensable for the organism and are not synthesized *de novo* therein.

Some of the factors of the energy problem in nutrition are discussed. Evidence is brought forth against the isodynamic law of RUBNER, concerning the energy equivalence of fats and carbohydrates approximately in proportion to their calculated heat equivalents. It is shown that one can speak of isodynamic quantities of various substances, but it does not follow that they are of equal value to the organism.

The book is profusely illustrated. It is to be regretted that its very high price will keep it out of the hands of many who would profit by it.

(*Harvard University.*) R. M. MAY.

Robert Theodor Gunther. (Magdalen College, Oxford). — *Early science in Oxford.* 2 vol. 408 p., XVI+408 p., with many plates and other illustrations. Oxford University Press, 1920-1923.

The chance discovery in a dark cupboard in Christ Church of the collection of instruments which once belonged to the Earl of ORRERY (d. 1731) is the initial accident to which we owe the present book. For it is that discovery which kindled GUNTHER's enthusiasm and which led to the Exhibition of Instruments in the Bodleian Library in 1919 and probably to the exhibition in Oxford of the invaluable series of instruments gathered by LEWIS EVANS and now offered by him as a gift to the University. The present book is essentially a *catalogue raisonné* of the ancient instruments available in Oxford, with many references to instruments exhibited in other places. But the author has added to this many biographical notices (some of them based on new documents) on the Oxford scientists of the past and much information of various other kinds.

The first volume is divided into three parts : 1. Chemistry; 2. Mathematics; 3. Physics and Surveying. I indicate briefly some of the contents of each part.

1. *Chemistry :* ROGER BACON; early apothecaries; pharmacy pots. Early laboratories (1645-1668) BOYLE. BOYLE introduced into Oxford the first regular teacher of practical chemistry in 1659; that was « the noted chimist and Rosicrucian, PETER STHAEL of Strasburgh in Royal Prussia, a Lutheran, a great hater of women and a very useful man » (Wood). JOHN LOCKE was one of his pupils. — Chemical arts : salt-glazed stone ware; use of nitrates in agriculture (experiments by Sir KENELM DIGBY and JOHN MAYOW. — The Restoration and the temporary decline of science in Oxford. JOHN MAYOW (the greatest chemist whom Oxford has ever produced). Other chemical laboratories. Glass manufacture.— The first university chemical laboratory, ELIAS ASHMOLE 1683 (Museum Ashmoleanum, Schola naturalis historiæ, Officina chymica). Philosophical Society, 1683. — Science teaching in the XVIII. century (JOHN WALL, founder of the Worcester Porcelain Co., 1751; Dr. SMITH; MARTIN WALL, 1781; THOMAS BEDDOES, 1788-1793; ROBERT BOURNE, 1790. — Early XIX. century. The Aldrichian professorship endowed in 1803. C. G. B. DAUBENY, professor from 1822 to 1854 (catalogue of his apparatus).

2. *Mathematics :* Notes on early mathematicians, for example, on the fellows of Merton who did so much for the glory of Oxford in the XIV. century. These notes are a little meagre (1), but we must not forget that GUNTHER's book is primarly a catalogue of instruments. An illustrated frontispiece derived from an unnamed Ms. gives a portrait of RICHARD WALLINGFORD, c. 1326 ! The portrait of

(1) They are completed in Vol. 2, p. 42-65.

ROBERT RECORDE, 1556, now in the possession of Mrs. DONE BUSHELL, serves as frontispiece to the third part (1). Among the mathematical instruments described are a XVII. century Cista mathematica (alas ! empty); models of solids; calculating apparatus (STANHOPE's Arithmetical Machine, 1780 and his Logic Demonstrator, 1777, which represents the first attempt to solve logical problems by a mechanical method); drawing instruments; porportional compasses; parallel rulers; protractors; elliptical trammel (before 1759); sectors; slide rules (with a brief chronology of the subject 1620-1850; the oldest known slide rule is OUGHTRED's circle of proportion, 1632); standard measures; NONIUS. This part is completed by notes on mathematical instrument makers from the XVI. century to the beginning of the XIXth.

3. *Physics and Surveying* (this part is as large as the two previous ones put together). The earliest Oxford invention is WALLINGFORD's horologe (1326) which is no longer extant. Of the great inventors of the XVII. and XVIII. centuries, very few instruments have survived, and this is a very strong argument for the creation of a special Museum where such monuments may be preserved and transmitted to posterity. GUNTHER's catalogue deals successively with various mechanical models (the most interesting is Lord ORRERY's wormjack, c. 1700); balances (dotchins, steelyards, etc.); time-keepers (nothing very ancient; the oldest clock in Oxford is the Turret clock of Magdalen, 1505); hydrostatic balances; hydrometers; barometers (the oldest dates of c. 1750); air-pumps (BOYLE's pump is lost; there are no XVII. century air-pumps in Oxford). No acoustical instruments have been preserved, but GUNTHER makes up for this by giving us a note on the echoes in the vicinity of Oxford and on ROBERT PLOTT's investigations of them (1677)! Other instruments described : thermometers; lenses and other optical apparatus, including WREN's description of his engine for grinding hyperbolical glasses, 1669; perspectographs; cameræ obscuræ; microscopes (MARSHALL's double microscope, 1693, and a good many others); magnets; electrical machines (the oldest is NAIRNE's frictional machine, c. 1760).

The section on *meteorology* (p. 315-324) begins with an account of WILLIAM MERLE's observations (1337-1344). Oxford contributed nothing more to the subject for three full centuries, when WREN appeared. Few instruments remain and these not very old (barometers, hygrometers, rain-gauges, wind-vanes). It seems that the Oxford weather-cocks are particularly erratic, being beaten only by the four weathercocks at St. Sepulchre's, London, where each maintains its own quarter !

(1) It is interesting to note that that rare and but recently discovered portrait is already included in D. E. SMITH's History of Mathematics, t. 1, 317, 1923 (reviewed above).

Surveying instruments : measures of length (WILKINS' way-wiser, c. 1678; GUNTER's chain, c. 1620; allusion to BLOUNT's taximeters, 1656); plumb levels (1554, c. 1579, etc.); bubble levels (HOOKE 1666, etc.); telescopic levels (1703, etc.). Note on ancient surveying instruments (p. 330-337). Quadrants and quadrates (DIGGES 1571; CHRIST. SCHISSLER, 1579). Triquetrum (FLUDD's Baculus geometricus and his Parallelogrammum, 1624); joint rule (1579, c. 1586, etc.); surveying sectors; cross-staffs and back-staffs (the latter invented by JOHN DAVIS, c. 1540); crossbows; octants and sextants; theodolites; plane-tables (their earliest ancestor is PHILIPPE DANFRIE's graphometre, 1597).

The second volume is entirely devoted to astronomy, and may be considered the fourth part of GUNTHER's work.

4. *Astronomy.* The Oxford collections begin with astrolabes and quadrants dating from the middle of the XIV. century. Their description is introduced by a clear summary of ancient instruments (prehistoric, Greek, Roman, Arabian, Persian) and a brief note on the transmission of Arabian learning to Oxford.

Astronomers of the middle of the XIV. century used the following instruments : CAMPANUS' instrument (a quadrant); the equatorium of JOHN DE LYNERS (JEAN DES LINIÈRES, I suppose); the equatorium of PROFACIUS (*i. e.*, JACOB BEN MACHIR IBN TIBBON, d. c. 1304); WALLINGFORD's Albion and rectangulus; the turquet or torquetum, in which two graduated circles are fixed in two planes at right angles to one another (invention ascribed to NASÎR AL-DÎN AL-Tûsî, also to JÂBIR B. AFLAH); the semissis, a semicircle with sight vanes and plumb-line used for measuring altitudes; the navicula de Venetiis, ship-shaped plate with two sight vanes, signs of the zodiac along the lower margin, a plumb-line and a pivoting mast upon which a latitude scale was marked (probably also of Muslim origin; the name *navicula* is probably a translation from the Arabic *zawraq*, name of an instrument described by SÉDILLOT, *Mémoire*, p. 182). This most interesting summary is completed in the appendices, which contain (p. 337-379) some of the fundamental texts bearing on this subject : WALLINGFORD's own description of the Albion and the rectangulus (both 1326), descriptions of the turquet and of the navicula from Mss. dating of the XIV. century. Then follows a good account of the Merton school of astronomy in the XIV. century (p. 42-65) when it was truly one of the greatest centres of scientific research in Europe.

The school of Merton was not unsignificant in the XV. century, but by that time astronomical leadership had already passed from Oxford to Germany. We have to wait until the XVII. century to

witness a sort of astronomical revival at Oxford; then appear SETH WARD, Savilian professor of astronomy 1649-1661, WREN, and finally EDMUND HALLEY (1656-1742). BRADLEY and THOMAS HORNSBY held the Savilian chair in the XVIII. century. The Radcliffe observatory was founded in 1771 and splendidly equipped — but it is shocking to realize that so little use was made of it, for no observations were published at Oxford before 1840 !

The catalogue proper begins with the study of *sundials* (p. 97-153). This includes a pleasant digression on NICHOLAS KRATZER, Oxford Reader immortalized by HOLBEIN'S portrait, 1528. KRATZER was a famous dial-maker, and some of his dials are represented upon his portrait. Many Oxford dials hare reproduced and described. The sundials are naturally followed by the *armillæ*, including the Earl of NORTHUMBERLAND'S magnificent armillary sphere, c. 1595.

Quadrants : some of the earlier ones are carefully described : JOHN OF MONTPELLIER'S *quadrans vetus* and PROFACIUS'S *quadrans novus;* other quadrants were devised by RECORDE 1556, GUNTER 1665, HOOKE 1666, etc. BOERHAAVE'S quadrant c. 1728, which became the property of Sir WILLIAM OSLER.

Astrolabes : the earliest dated astrolabe known, dated A. H. 374 = 984, is at Oxford (1), GUNTHER'S notes on this subject are particularly welcome. They include a list of Muslim astrolabe makers (p. 190), a table of dated astrolabes by early makers, a comparative table of star names on astrolabes (from 1224 to 1565), an account of the mariner's astrolabe (invented c. 1484), notes on designers and makers of astrolabes, dials and other instruments.

Volvelles and æquatoria : Sun and Moon volvelles were handy circular scales by means of which calendrical calculations could be readily performed; planetary volvelles or æquatoria were systems of graduated disks used for finding approximate places of sun, moon, and planets without the use of tables, the latitude being quite ignored. The earliest volvelles known date of the first half of the XIV. century; the æquatoria were probably a later invention (XV. century).

Astronomical models. The celestial globe of the Dresden museum is quoted as dating of 1289. It is not a little earlier, c. 1279 ? (See STEVENSON, Terrestrial and celestial globes, 1921, t. 1, 30; *Isis*, IV, 551). The earliest globe in Oxford is a Cufic one dated 1362; an analysis of it provided by E. B. KNOBEL is given on p. 247-9. The earliest terrestrial globe in Oxford is one of 1567. Many beautiful orreries and planetaria are reproduced and described.

Nocturnals or night dials, used to deduce the time readily from observations of the position of some particular stars, for which

(1) Two *undated* astrolabes, respectively in Paris and Palermo, date of c. 950 and c. 964.

the instrument was constructed, relatively to the Pole Star. The earliest descriptions of it occur in SEB. MÜNSTER's Horologiographia, 1533, and in APIAN's Cosmographia, 1539 (where it is called instrumentum syderale).

Almanachs and calendars (p. 277-287).

Telescopes. There are no XVII. century telescopes in Oxford, but the Royal Society has various object glasses bearing HUYGENS' signature and dated 1686. Many telescopes of various types, which form a part of the ORRERY collection, date of c. 1700-1710 (of course, some may be just a little earlier and date of the XVII. century).

GUNTHER's work contains descriptions of all the astronomical instruments of the ORRERY collection and of the splendid set of instruments made by J. BIRD (d. 1776) for the Radcliffe Observatory in the second half of the XVIII. century. I have no space to dwell upon them. Suffice it to say that these two collections illustrate splendidly the state of astronomical equipment at the beginning and at the end of the XVIII. century. That is, the equipment which wealthy amateurs would obtain, but it is saddening to think that such equipment was not necessarily found in great observatories (as late as 1720 the Royal Observatory at Greenwich was absolutely without instruments of any kind ! !), or when found, as in the Radcliffe Observatory, was hardly used.

Besides the appendices already quoted, I must still mention the following : Catalogue of the Library of WILLIAM REDE, bishop of Chichester, d. 1385. Notes on certain Bodleian codices, containing descriptions or figures of astronomical instruments. Documents relating to WREN (p. 289-394). Documents relating to the Radcliffe Observatory, etc.

I have said enough to give an idea of the wealth of material which we owe to R. T. GUNTHER. His work is a fundamental contribution to the archæology of science. It contains many valuable lists of instrument makers, English and foreign. The illustrations are abundant and, some of them, splendid. The material is not always presented in the best order, but this defect is offset by an excellent index. Instead of the grouping of instruments chosen by the author, I would have preferred a chronological grouping, at least for the earlier ones. I would like to be able to see at a glance which instruments remain of the XIV. century, of the XVth, etc. In any case, a synoptic table in strict chronological order would have been very useful.

GEORGE SARTON.

Bourgin, Hubert. — *Les systèmes socialistes.* 420 p., in-16, GASTON DOIN, Paris, 1923 [15 fr.]

Cette étude, que l'auteur donne comme un guide pour l'étude des systèmes socialistes, est strictement bornée à l'histoire des systèmes,

et ne s'étend pas à celle des hommes, des partis, des mouvements politiques, des agitations populaires; mais la théorie socialiste est trop intimement liée à l'action socialiste pour que ne soient pas notés leurs points d'attache : des indications sont sommairement données à ce sujet chaque fois qu'il en est besoin. L'œuvre est divisée en quatre parties. Dans la première (20 p.), BOURGIN définit et détermine les éléments des systèmes socialistes, et passe en revue les antécédents de ces systèmes dans les philosophies française et anglaise, sans remonter au delà du XVIII[e] siècle. La seconde partie (pp. 21-168) expose les systèmes socialistes de 1789 à 1848 : thèses socialistes pendant la Révolution, BABEUF et la doctrine des Égaux, systèmes anglais, ROBERT OWEN, doctrines de SAINT-SIMON, de FOURIER et leurs écoles, origines du syndicalisme et du coopératisme, système humanitaire et religieux de PIERRE LEROUX, communisme religieux et coopératif de BUCHEZ, communisme démocratique de CABET, communisme progressif et religieux de PECQUEUR, christianisme social de LAMENNAIS, thèse de LOUIS BLANC, doctrine de PROUDHON de 1840 à 1848, origines du socialisme allemand : GALL, WEITLING et MARR, STIRNER, RODBERTUS, MARX et ENGELS. Deux chapitres sur le Manifeste communiste et sur le socialisme français de 1848 ferment cette période. La troisième partie (pp. 169-304) va des débuts du marxisme au congrès d'Amsterdam (1904) qui consacre l'unification marxiste du socialisme. BOURGIN y étudie successivement la doctrine marxiste, le socialisme français de 1848 à la Commune, dominé par PROUDHON, les doctrines du socialisme chrétien en Angleterre, l'individualisme interventionniste de STUART MILL, le socialisme de RODBERTUS, LASALLE, les théories de l'anarchisme de BAKOUNINE, le blanquisme, les doctrines antagonistes et dissidentes du marxisme, le marxisme international aboutissant après une série de congrès à la charte d'Amsterdam. Enfin, dans la dernière partie, l'auteur décrit ce qu'il appelle la décomposition du socialisme : révisionnisme, réformisme, antipatriotisme, anarchisme, néo-guesdisme, syndicalisme révolutionnaire, etc., il étudie le socialisme à la veille de la guerre, sa dislocation pendant la guerre, et sa transformation en bolchevisme. Cet ensemble, établi sans parti-pris, constitue bien un guide pour quiconque voudra pousser plus à fond cette étude; les indications bibliographiques qui suivent chaque chapitre faciliteront ce travail. L. G.

Aimé Witz. — ***Traité théorique et pratique des moteurs à gaz, à essence et à pétrole.*** 5[e] édition entièrement remaniée et mise à jour. 2 gros vol. (29×19 cm), faisant plus de 1300 p., 379 fig. Paris, ALBIN MICHEL, 1923. [75 fr.]

M. AIMÉ WITZ, correspondant de l'Institut, dont j'ai analysé antérieurement (*Isis*, V, 561) une histoire des théories électriques, a

consacré la meilleure partie de sa vie et de son enseignement à la Faculté libre des Sciences de Lille, à l'étude des moteurs à gaz. Sa première publication sur ce sujet remonte à 1878 et la première édition de son traité parut en 1886 (2e éd., 1889; 3e éd., 1891; 4e éd., 1903). Sous sa forme actuelle ce traité est probablement le plus complet qui ait été publié. Il est à la fois comme l'indique le titre, théorique et pratique, et rendra des services aux industriels aussi bien qu'aux ingénieurs. La matière est divisée comme suit :

Tome I. 1. Histoire (v. *infra*); 2. Classification des moteurs à gaz; 3. Considérations théoriques sur les machines thermiques; 4. L'aliment des moteurs; 5. Théorie générique des moteurs à gaz; 6. Théorie expérimentale des moteurs à gaz; 7. La théorie des turbo-moteurs à gaz; 8. Essais des moteurs. — *Tome II.* 9. Les carburateurs; 10. Les gazogènes; 11. Appareils d'épuration pour gaz de gazogènes, de fours à coke et de hauts fourneaux; 12. Moteurs à quatre temps; 13. Moteurs à gaz à deux temps; 14. Moteurs à gaz à combustion; 15. Moteurs à pétrole à explosion; 16. Moteurs DIESEL et semi-DIESEL; 17. Moteurs légers et ultra-légers d'automobiles et d'avions; 18. Les turbines à gaz; 19. Etude comparative des éléments de construction des moteurs; 20. Applications des moteurs.

L'histoire qui forme l'introduction naturelle de cet ouvrage ne comporte pas moins de 73 pages et est la plus étendue que je connaisse. Elle est spécialement importante à cause de la longue expérience, à la fois théorique et pratique, de l'auteur. Il l'a vécue en grande partie. Il n'est pas seulement un historien mais un témoin. Cette histoire est divisée en trois parties : 1. *La période de tâtonnement* qui commence avec l'abbé JEAN HAUTEFEUILLE, fils d'un boulanger d'Orléans, en 1678 et 1682. Il peut sembler de prime abord paradoxal d'attribuer l'idée première des moteurs à gaz à un savant qui est mort plus de cent ans avant que LEBON n'eût extrait le gaz de la houille, mais rappelons-nous que les moteurs à gaz sont presque tous des appareils à explosion qui procèdent en ligne directe des machines à poudre. HUYGENS, à qui la priorité de cette invention est parfois attribuée, ne publia son mémoire y relatif que deux ans plus tard, en 1680. Après cela il faut attendre plus d'un siècle — jusqu'à JOHN BARBER, 1791 — avant d'enregistrer un nouveau progrès. Cette fois, l'invention est vraiment en marche. J'indique brièvement les brevets principaux qui sont comme des bulletins de victoire : ROBERT STREET, 1794; PHILIPPE LEBON, 1799 (LEBON compléta presque l'invention et sans doute il l'eut complétée tout à fait s'il avait vécu plus longtemps, mais il fut assassiné à Paris en 1804, à l'âge de 35 ans); WELLMANN WRIGHT, 1833; JAMES JOHNSTON; WILLIAM BARNETT, 1838; BARSANTI et MATTEUCCI, 1854; HUGON, 1858; Sir WILLIAM SIEMENS, 1860. — 2. *La période d'invention* qui débute avec le brevet de LENOIR du 24 janvier 1860, intitulé : « Moteur à air dilaté par la combustion du gaz ». — 3. *La période d'expansion* qui commence vers 1889 : le moteur était sur

pied, il n'y avait plus qu'à l'adapter aux exigences diverses de ses multiples emplois. Je ne puis songer à résumer ici l'histoire de ces deux dernières périodes. Mon résumé deviendrait une énumération monotone; je dois renvoyer le lecteur au livre analysé.

Le seul défaut de ce grand ouvrage c'est le manque d'un index copieux. Celui qui termine le traité en est tout à fait indigne. J'espère qu'une sixième édition permettra bientôt à l'auteur de combler cette lacune.

GEORGE SARTON.

Bashford Dean. — *A bibliography of fishes.* 3 vol. American Museum of Natural History, New York, 1916-1923. Vol. I and II, enlarged and edited by CHARLES ROCHESTER EASTMAN (1868-1918). Authors' Titles, 1916-1917. XII+718 p.; IV+702 p. Vol. III, extended and edited by EUGENE WILLIS GUDGER with the cooperation of ARTHUR WILBUR HENN. Including indices, etc., 1923. XVI+707 p

This monumental work, the compilation of which was begun some thirty years ago by BASHFORD DEAN, is now completed, and our first thought is one of gratitude to the inceptor, first editor, and animator of the great undertaking, to the assistant editors who carried it out so faithfully, and to the American Museum which assumed the burden of publishing it, and did it so handsomely. The department of ichthyology of the Museum is very young : it dates only from 1909 (and until 1920 it was not even independent but was only a part of a larger department including also herpetology). In so short a time it has done wonders, for it can already boast a fine collection of fossil fishes and of many interesting restorations (*e. g.*, of *Dinichthys*, and of the jaws of *Carcharodon*, the most formidable fish known), — remarkable exhibitions of recent fishes (including luminiferous deep-sea fishes), — extensives study collections, — but the greatest wonder of all is the publication of this enormous and excellent bibliography — which is, I believe, unique of its kind. At least, I do not know of anything equivalent to it for any other department of natural history.

Let us describe it. The first two volumes contain a list of about 50 000 papers dealing with Fishes broadly (including Cyclostomes and Amphioxus) which appeared between 1758 (date of the 10th edition of the *Systema Naturæ*) and 1914 (1). These papers are classified by authors. Thus, if one turns to the name of DAVID STARR JORDAN, the Nestor of American ichthyologists, one finds not less than 34 columns devoted to him ! For such long lists as these it would have been useful to give some prominence by means of an

(1) Some later publications are occasionally included.

asterisk or of heavier type to the most important publications, but the users of this work will probably mark with their pencil the items of greater interest to them. I looked up GÉHIN — and I wonder whether the second GÉHIN quoted together with REMY (not RÉMY) is not ANTOINE instead of JOSEPH JEAN BAPTISTE ? At any rate the two papers quoted under their names (vol. I, 446) complete very usefully GUINET's note on the subject in *Isis*, V, 403-405.

This part ends with a list of anonymous titles (vol. II, 677-702, vol. III, 1-3). Anonymous titles are a perfect nuisance, in many ways, and I have often thought that the editors of scientific journals should positively refuse to insert unsigned papers. If an author wishes to remain unknown, he should sign his papers with a pseudonym which would become their hall-mark. In other words, the reader has a right to know who wrote the papers submitted to him, or at least he must be given the possibility of classifying them with regard to their origin. In the meanwhile, anonymous papers exist, and the bibliographer must make the best of them.

Vol. III is the most precious of the three. It is largely due to the combined efforts of EASTMAN, GUDGER, and HENN. Down to 1919 most of the work was done by the former; after that, E. W. GUDGER contributed extensive addenda and expanded and completed the Pre-Linnaean literature while A. W. HENN devoted most of his energy to the morphological section, especially to the encyclopedic articles. Outside of the unavoidable Addenda (203 p.), it contains the following sections :

Titles of Pre-Linnaean publications. This section will certainly be the most valuable to the historian of biology. I have read many pages of it with much pleasure. We find in it the names not simply of every ichthyologist of the past, but also of every man of science or encyclopedist who dealt with fishes. For example, Saint THOMAS AQUINAS is included, because Clupeoid fishes named Sarda and Harenga are mentioned in his Summa in connection with canonizing ceremonies ! « The first of these names occurs also in ISIDORE and seems to refer to the sardine. » By the way, PLANCUS was GIOV. BIANCHI's pseudonym and not the opposite (p. 217), and one should read FRACASTORIUS (or better, FRACASTORO) instead of FRASCATORIUS (p. 245). But when I do not find in a book more and worse errors during a full hour of random reading, I conclude that the book was written and corrected with singular care. The dates of birth and death of each author are given, and biographical, bibliographical, and critical notes are generously added. Some important works are briefly analyzed. For example, the contents of each part of ARTEDI's *Ichthyologia* (1738) are indicated.

General bibliographies which include references to fishes (also fisheries, pisciculture, and angling), p. 338-342.

Voyages and expeditions which relate to fishes, p. 343-347.

Periodicals relating to fish and fish culture, p. 348-353.

Errata and corrigenda, p. 354-360.

Follow the indexes : Firstly, a ***Morphological and general section*** (p. 361-614) arranged under 118 technical headings, of which many are subdivised by means of subheadings. It is a pity that the editors did not place at the beginning of this section a brief table of those headings and subheadings, allowing one to appreciate at a glance the economy of the whole and the proportions of its different parts. This is the more regrettable in that this index is really of an encyclopedic nature because of the many summaries following the headings. Let me quote a few of these at random : abdominal pores; air bladder; alimentary canal; anatomy and morphology; angling; aquaria and aquarium fishes (372-379); archæology (*i. e.*, fishes in prehistoric times; American and classical archæology); behavior; brain (with references to nervous system; cross-references are very generously provided throughout); dentition, etc., etc.

Systematic section (p. 615-666). Subject index in systematic order arranged, in general, according to the system used in the Cambridge Natural History. It deals with the separate families and higher groups, sometimes with individual genera, but goes rarely below that, save in the case of the fishes of great economic as well as scientific importance (*e. g.*, Anguilla, Pleuronectidæ, Salmonidæ, etc.).

Finally, a ***Finding index*** (p. 667-707), containing not simply all the headings and subheadings of the first two indexes but many other words as well. Thus the reader will do best to refer first of all to the finding index, even if he already knows where the main heading relative to his subject is located.

One of the authors of this great work, E. W. GUDGER, is specially interested in historical questions and is well known to the readers of *Isis* (1). BASHFORD DEAN, the ichthyologist, is well known, too. Not to speak of his many smaller contributions, his textbook ***Fishes, living and fossil***, New York 1895 has been used by many students, and his ***Studies on fossil fishes (sharks, chimaeroids, and arthrodires)*** in the ***Memoirs of the American Museum***, 1909, are held in high esteem. But many zoologists and many readers of *Isis* may not be aware that DEAN has been living all these years a double life — there was the ichthyologist, there is also, more and more predominantly, the collector and student of ancient arms and armor ! The magnificent collection of the Metropolitan Museum, now one of the finest in the world, was largely organized by him, and he has published many valuable contributions to that branch of archæology. I mention only the most important : (1) Handbook

(1) A paper of his is included in the present number of *Isis*. He has been often quoted in our Critical Bibliographies (*Isis* II, 269; III, 154, 371; IV, 646).

of arms and armor European and Oriental, 1915; (2) Notes on arms and armor, 1916; (3) Helmets and body armor in modern warfare, 1929 (1 and 2 published by the Metropolitan Museum; 3 by the Yale University Press).

It would be interesting to hear how BASHFORD DEAN was led to combine these apparently divergent activities and how it came to pass that fishes and arms shared his devotion. Was it the study of the exoskeleton and of the scales of certain fishes which led him to the study or armor, or vice versa? Autobiographical reminiscences would be welcome from one who has spent so successfully a double life, a life of double usefulness, and who can write in such a racy manner.

GEORGE SARTON.

Materials for the Biography of Contemporary Scientists

(chiefly obituary notices)

Compiled by

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For previous lists see *Isis*, I, 172-173, 311-312, 560; III, 120-123; IV, 161-171; V, 244-262.

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